# UM1574
# User manual

## STM8A-DISCOVERY
## Discovery kit for STM8A microcontrollers

## Introduction

The STM8A-DISCOVERY helps you discover the STM8AF and STM8AL automotive microcontroller family features and develop your applications through two dedicated application boards that can be connected together via a LIN network.

The STM8AF board can perform both CAN and LIN communications with the MCU powered at 5 V and is ready to be connected into a network with its integrated transceiver.
The STM8AL board manages LIN slave communication through its transceiver and uses a 4-digit alphanumeric LCD display with the MCU powered at 3.3 V, offering low energy power modes.

Both STM8AF and STM8AL boards include push buttons, LEDs, external connectors and allow various configurations to take advantage of the numerous capabilities of the microcontrollers.

**Figure 1. STM8A-DISCOVERY**

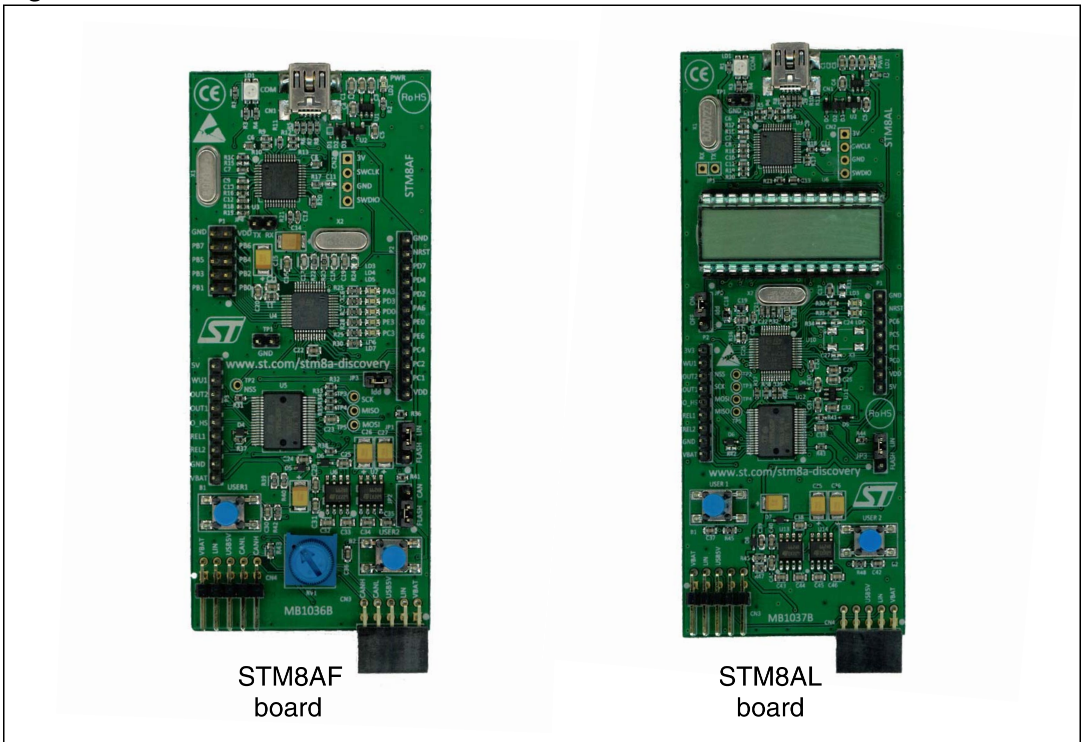



**Figure 2. Applicable tools**

| Type | Part number |
|---|---|
| Evaluation tools | STM8A-DISCOVERY |

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# 1 Conventions

*Table 1* provides the definitions of some conventions used in the present document.

**Table 1. ON/OFF conventions**

| Convention | Definition |
|---|---|
| Jumper JPx **ON** | Jumper fitted |
| Jumper JPx **OFF** | Jumper not fitted |
| Jumper JPx **1-2** | Jumper is fitted between pins 1 and 2 |
| Jumper JPx **2-3** | Jumper is fitted between pins 2 and 3 |
| Solder bridge SBx **ON** | SBx connections closed by solder |
| Solder bridge SBx **OFF** | SBx connections left open |

# 2 Quick start

The STM8A-DISCOVERY is a low-cost and easy-to-use development kit to quickly evaluate and start a development with STM8AF and STM8AL microcontrollers family devices. STM8AF devices offer high performance and full automotive network connectivity with high speed CAN and LIN master/slave modes communications. STM8AL devices offer high performance with ultra-low power management. Both comply with automotive qualification and conform to AEC-Q100 rev G.

For more information on the STM8A-DISCOVERY and for demonstration software, visit www.st.com/stm8a-discovery.

## 2.1 Getting started

1. Connect CN3 and CN4 on the STM8AF board to CN3 and CN4 on the STM8AL board.
2. Connect both type A connectors of the USB cable to a PC.
3. Then connect the mini-B connector of the USB cable to the STM8AF board.
4. All LEDs blink once on the STM8AF board and twice on the STM8AL board, then the LIN communication between both boards starts.
5. Turn the RV1 trimmer on the STM8AF board to adjust the value from 0 to 100 on the STM8AL board LCD through the LIN bus.
6. Push button USER1 on the STM8AF board to sequentially display the LCD bars on the STM8AL board through the LIN bus. Push button USER2 on the STM8AF board to sequentially switch them off one by one.
7. Push button USER1 on the STM8AL board to sequentially switch on green LEDs LD4, LD5, LD6 and LD7 on the STM8AF board through the LIN bus. Push button USER2 on the STM8AL board to sequentially switch them off one by one.
8. To perform or modify the Discover project related to this demo, visit www.st.com/stm8a-discovery.
9. You can discover the STM8AF and STM8AL features, download and execute programs proposed in the list of projects.
10. You can then develop your own application using the available examples.

## 2.2 System requirements

- Windows PC (XP, Vista, 7)
- USB cable (dual type A to mini-B) - included

## 2.3 Development toolchains supporting the STM8A-DISCOVERY

- IAR: EWSTM8
- STMicroelectronics: STVD

# 3 Features

The STM8A-DISCOVERY offers different features combined with STM8AF and STM8AL boards:

**STM8AF and STM8AL common board features:**

- On-board ST-LINK/V2 included for debugging and programming
- Board power supply: through 5 V USB bus
- Internal dual ST662A step-up converter building the 12 Vdc when powered by USB port
- External application power supply $V_{BAT}$ (up to 14 Vdc)
- 16 MHz HSE XTAL crystal oscillator
- L99PM62GXP power management IC with LIN and high speed CAN with SPI control interface and high-side drivers
- Two push buttons (USER1 and USER2)
- Extension header for L99PM62GXP including relays, high-side outputs and wake-up capabilities

**STM8AF dedicated board features:**

- STM8AF5288T microcontroller featuring 64 Kbytes Flash, 2 Kbytes data EEPROM, LIN, CAN in an 48-pin package
- Seven LEDs:
  - LD1 (red/green) for USB communication
  - LD2 (red) for 5 V power ON
  - Five user LEDs LD3 (red) and LD4 to LD7 (green)
- RV1 potentiometer connected to the ADC peripheral
- Extension headers for MCU connectivity (full Port B, free ports pins, RESET)

**STM8AL dedicated board features:**

- STM8AL3L68T microcontroller featuring 32 Kbytes Flash, 1 Kbytes data EEPROM, LCD in an 48-pin package
- Four LEDs:
  - LD1 (red/green) for USB communication
  - LD2 (red) for 3.3 V power ON
  - 2 user LEDs LD3 (red) and LD4 (green)
- 4-digit alphanumeric LCD display including 4 bars display
- Extension header for MCU connectivity (free ports pins, RESET)

# 4 Hardware and layout

This section describes STM8A-DISCOVERY hardware and layout which can be broken down into common resources used both in STM8AF and STM8AL boards and the special features belonging to each of them.

## 4.1 STM8A-DISCOVERY common resources

### 4.1.1 Embedded ST-LINK/V2

The ST-LINK/V2 programming and debugging tool is integrated both in STM8AF and STM8AL boards. The embedded ST-LINK/V2 can be used to program/debug the MCU on the board and supports SWIM for STM8 devices.

The ST-LINK/V2 must be connected with the dual type A to mini-B USB cable provided in the blister.

**Caution:** First connect the dual type A on the PC side (both type A connectors must be plugged in) then connect the mini-B USB to the board (STM8AF or STM8AL boards).

For programming or debugging the STM8A-DISCOVERY, the PC can be either connected to the mini-B USB connector of the STM8AF or STM8AL board.

The connection on both mini-B usb of the STM8AF and STM8AL boards is not supported. This operation can damage the boards.

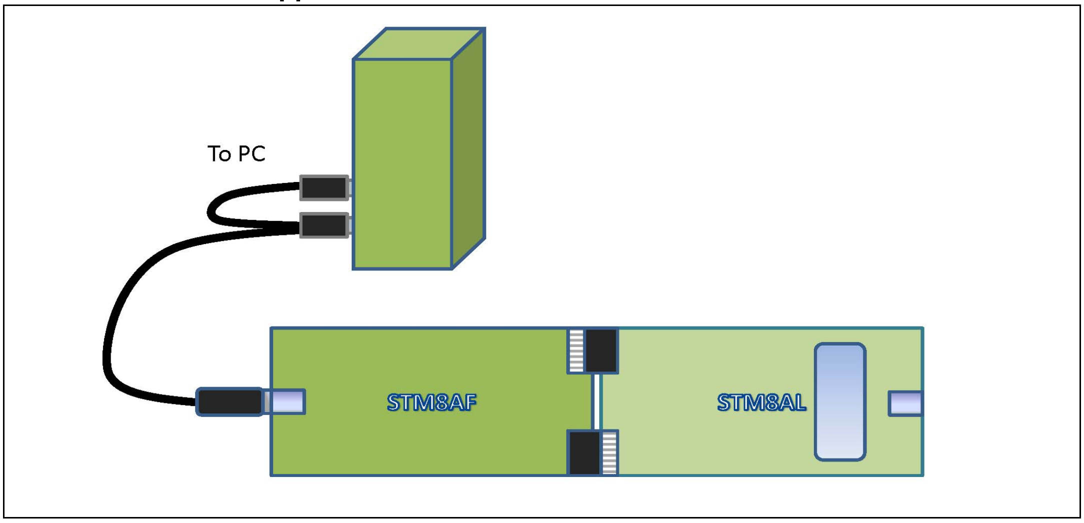
For information about debugging and programming features refer to user manual UM1075 (ST-LINK/V2 in-circuit debugger/programmer for STM8 and STM32) which describes in detail all the ST-LINK/V2 features.

### 4.1.2 Debugging STM8A-DISCOVERY

The STM8A-DISCOVERY is composed by a STM8AF board connected to a STM8AL board. A PC can be connected to the STM8AF or STM8AL board side while programming/debugging the STM8AF5288T or the STM8AL3L68T.

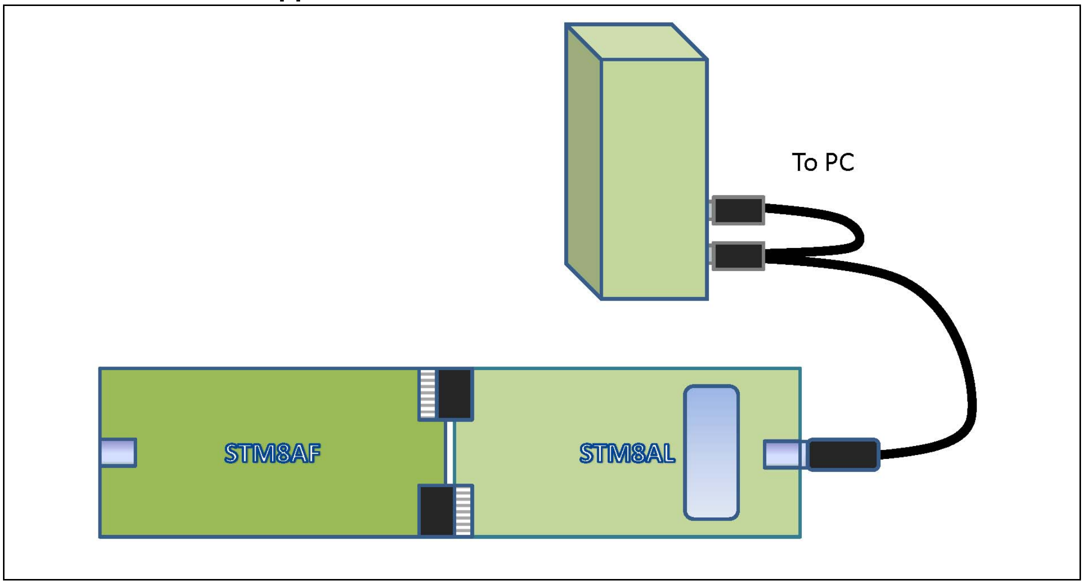
- Example 1: Debugging the STM8AF microcontroller when the STM8AL board or an external application board is connected.

**Figure 3. Debugging the STM8AF microcontroller when the STM8AL board or an external application board is connected**




- Example 2: Debugging the STM8AL microcontroller when the STM8AF board or an external application board is connected.

**Figure 4. Debugging the STM8AL microcontroller when the STM8AF board or an external application board is connected**




*Note: All other configuration are not supported and could damage the boards or the PC.*

### 4.1.3 Power supply

The power supply is provided by the host PC through the dual type A to mini-B USB cable or by an external $V_{BAT}$ power supply (12 Vdc typical, 14 Vdc max).

One dual type A to mini-B USB is needed to provide the current required by the STM8AF and STM8AL boards when they are connected together.

**Reminder:** First connect the dual type A on the PC side (both type A connectors must be plugged in) then connect the mini-B USB to one of the STM8Ax boards.

When the STM8AF board is connected to the STM8AL board, different schemes are possible:

- The USB cable is used to simply provide the power supply to the STM8A-DISCOVERY. In that case, it can be connected either to the STM8AF or STM8AL board side.
- While programming/debugging the STM8AF or STM8AL board with your PC, the USB cable must be placed on the appropriate side of the board depending on which board is being debugged (see *Figure 3* and *Figure 4*).
- If no programming/debugging operations are needed (no PC connected) or if a larger amount of current is required (higher than 200 mA @5 V), then the power supply must be wired between the $V_{BAT}$ and GND pins of the STM8AF or STM8AL board. $V_{BAT}$ is indeed internally distributed through the two boards. Therefore, $V_{BAT}$ can be wired indifferently on the STM8AF or STM8AL board (not on both).

On the other hand, if the STM8AF or STM8AL board is used in standalone (not connected together), they can be supplied either by the USB cable or by the external $V_{BAT}$. As for instance, this configuration can be used when the boards are inserted in an automotive network.

The STM8AF and STM8AL boards include an internal 5 V to 12 V step-up converter that is needed to build the voltages required for LIN or CAN networks. The 5 V USB is then converted into 12 V voltage that supplies the integrated L99PM62GXP power management IC. This device includes a 5 V regulator which is connected directly to the STM8AF5288T microcontroller or transformed subsequently into 3.3 V to supply the STM8AL3L68T microcontroller.

The power supplies of STM8AF5288T and STM8AL3L68T are provided by the L99PM62GXP power management IC on condition that the microcontrollers sequentially refresh the watchdog included in the L99PM62GXP devices. This functionality exists when the L99PM62GXP is in Active mode (standard operation). In that case, if the L99PM62GXP device is not refreshed periodically, the 5 V power supply is provisionally shutdown until a next start-up sequence is performed. This behavior can generate some issues when the SWIM communication tries to establish a connection with the microcontroller and when the latter is not power supplied. To remedy to this situation and to avoid caring about L99PM62GXP watchdog refresh, the L99PM62GXP can be placed in Flash mode by configuring some dedicated jumpers (see *Section 4.2.5*). This prevents to cut the power supply to the microcontroller as for instance for software debugging. This behavior is only present on the STM8AF board as the STM8AL board is always put in Flash mode by design.

### 4.1.4 L99PM62GXP power management IC with LIN and high speed CAN

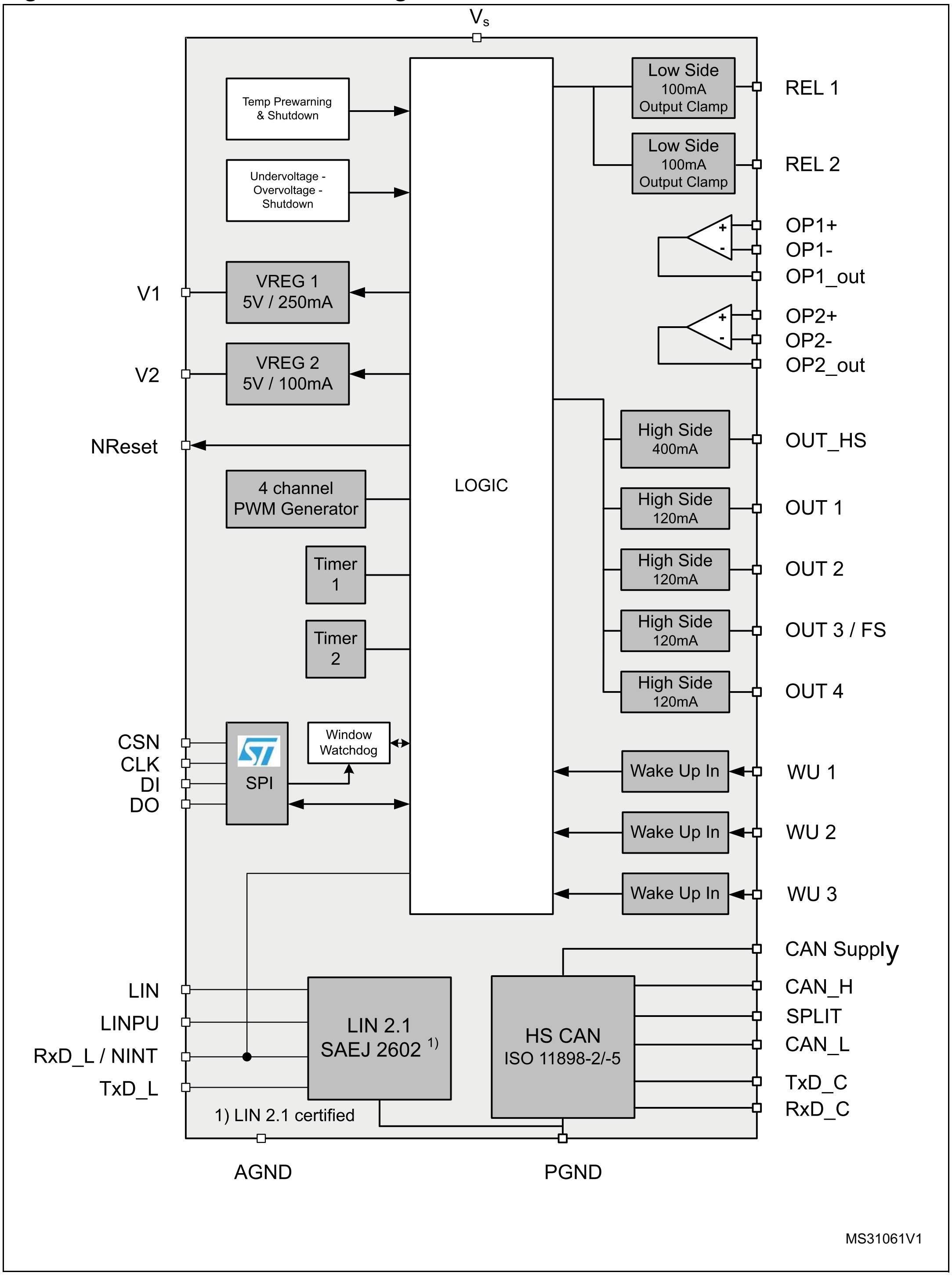
The L99PM62GXP is a power management system IC that provides electronic control units with enhanced system power supply functionality, including various standby modes, as well as LIN and HS CAN physical communication layers. The device's two low-drop voltage regulators supply the system microcontroller and external peripheral loads such as sensors

and provide enhanced system standby functionality with programmable local and remote wake-up capability.

The microcontrollers of the STM8AF and STM8AL boards communicate with the L99PM62GXP IC through the SPI interface, that allows control and diagnosis of the device. A lot of features are offered to control low and high-side drivers using the embedded and configurable PWM timers, window watchdog, wake-up capability. Some of their outputs are available at external headers of the STM8AF and STM8AL boards. This device is a power SS0-36-pin package.

*Figure 5* illustrates the L99PM62GXP block diagram. For further information on the L99PM62GXP device and to explore its numerous capabilities, please refer to datasheet available at www.st.com.

**Figure 5. L99PM62GXP block diagram**



## 4.2 STM8AF board dedicated resources

The STM8AF board is designed around the STM8AF5288T microcontroller in a 48-pin LQFP package.

*Figure 6* illustrates the connections between the STM8AF5288T and the different peripherals (ST-LINK/V2, L99PM62GXP IC, push buttons, LED and connectors).

*Figure 6* and *Figure 7* help you locate these features on the STM8AF board.

**Figure 6. STM8AF board hardware block diagram**

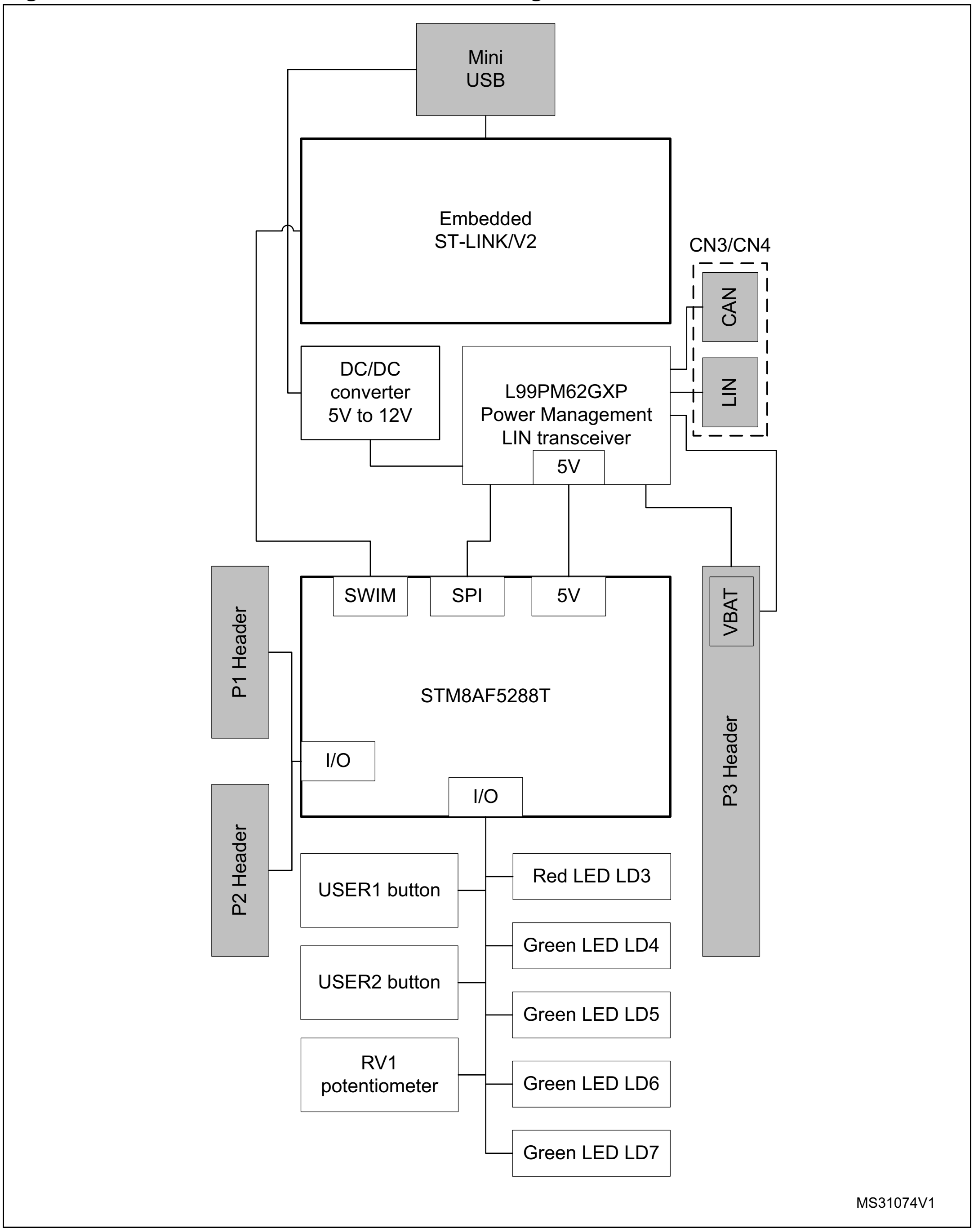


**Figure 7. STM8AF board top layout**

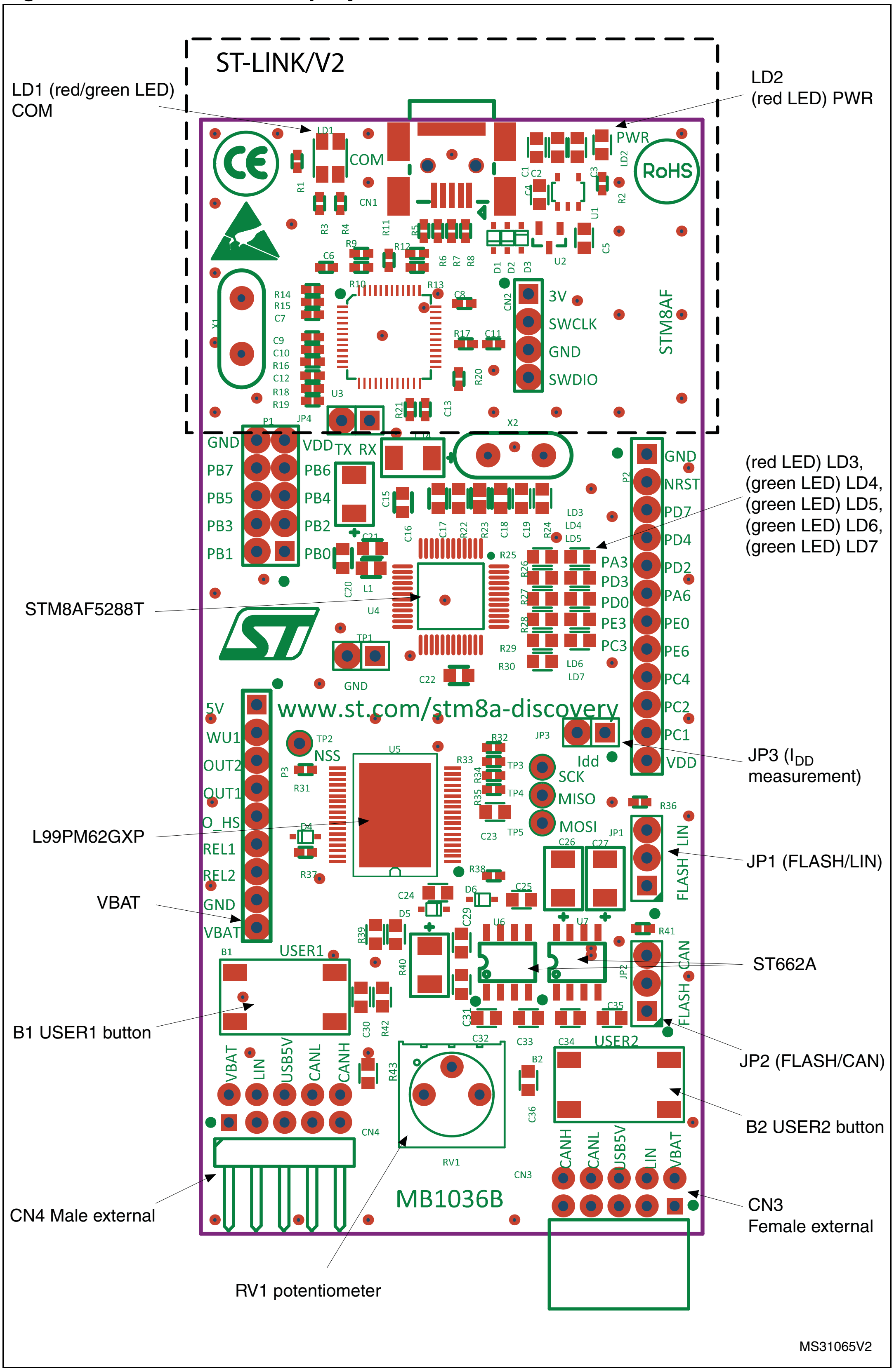
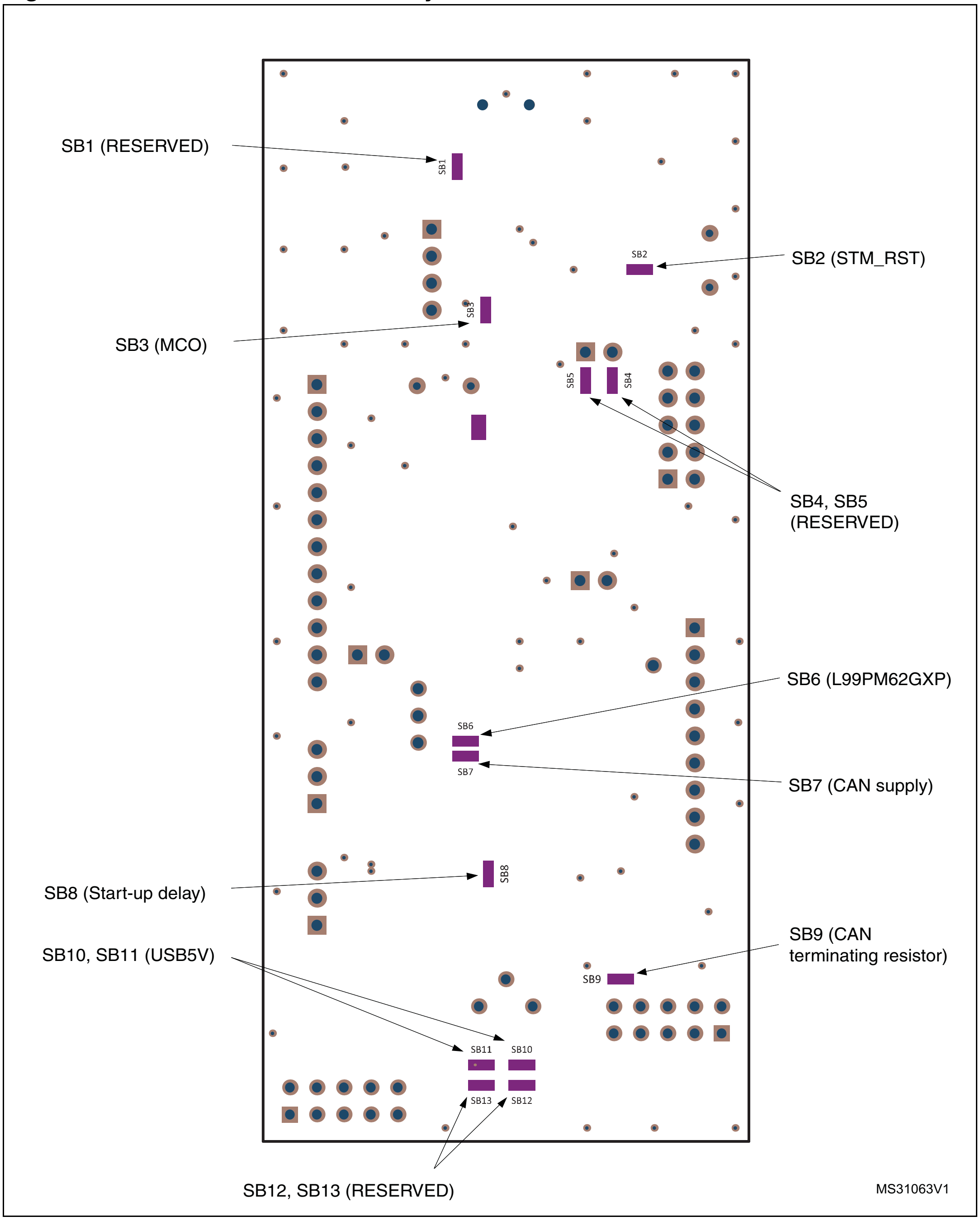


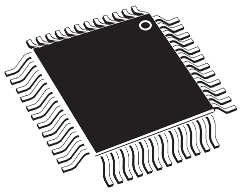
Figure 8. STM8AF board bottom layout



### 4.2.1 STM8AF5288T microcontroller

This automotive 8-bit MCU has 64 Kbytes Flash, 2 Kbytes data EEPROM, 10-bit ADC, timers, LIN, CAN, USART, SPI, I2C and operates from 3 to 5.5 V.

**Figure 9. STM8AF5288T package**




The STM8AF5288T automotive 8-bit microcontroller offers 64 Kbytes of non-volatile memory and integrated true data EEPROM.

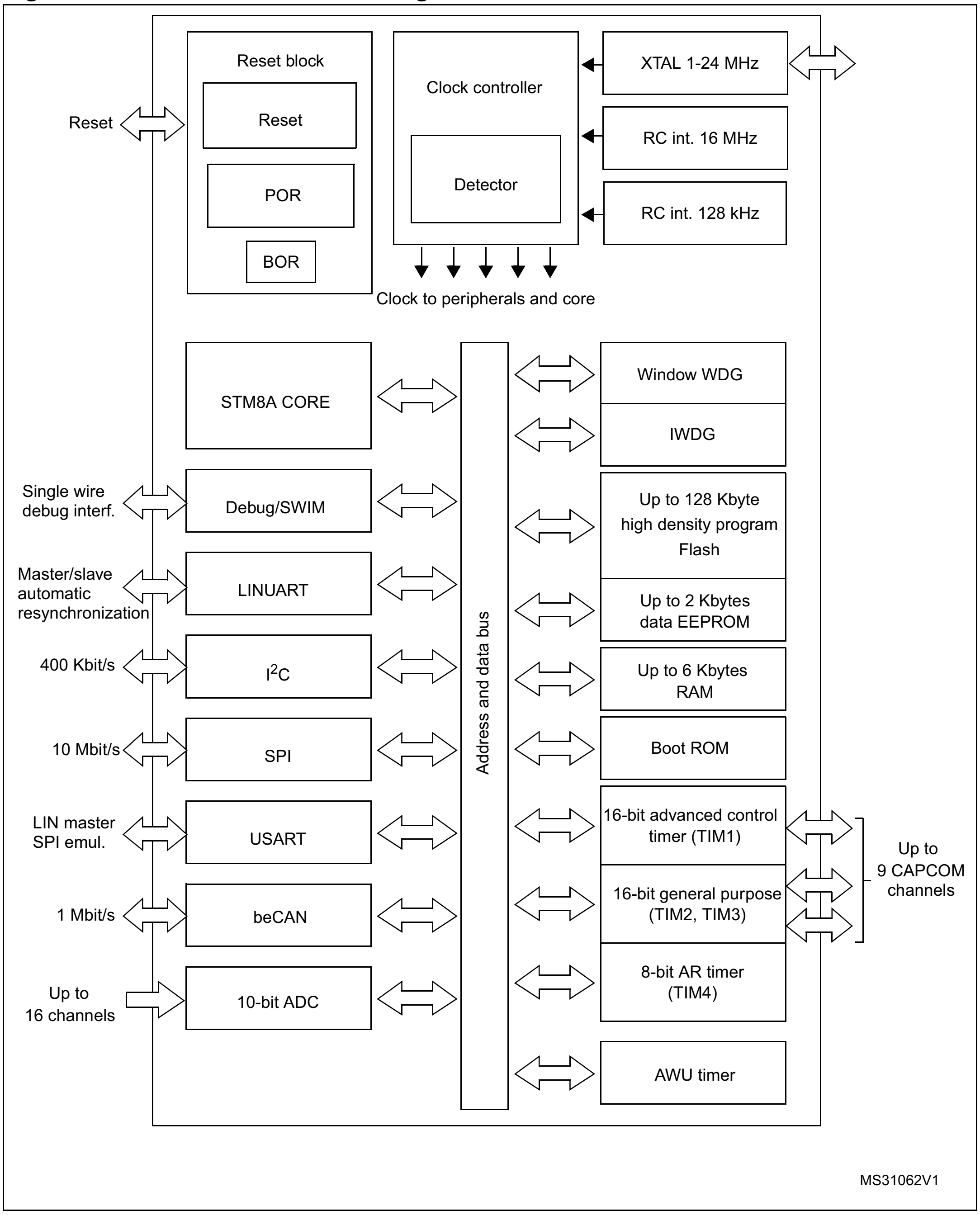
The STM8AF52xx series feature a CAN interface.

All devices of the STM8A product line provide the following benefits: reduced system cost, performance and robustness, short development cycles, and product longevity.

- Reduced system cost
  - Integrated true data EEPROM for up to 300 k write/erase cycles
  - High system integration level with internal clock oscillators, watchdog and brownout reset
- Performance and robustness
  - Peak performance 20 MIPS at 24 MHz and average performance 10 MIPS at 16 MHz CPU clock frequency
  - Robust I/O, independent watchdogs with separate clock source
  - Clock security system
- Short development cycles
  - Applications scalability across a common family product architecture with compatible pinout, memory map and modular peripherals.
  - Full documentation and a wide choice of development tools
- Product longevity
  - Advanced core and peripherals made in a state-of-the art technology
  - Native automotive product family operating both at 3.3 V and 5 V supply

The STM8AF and STM8AL boards are supported by the same tools including STVD/STVP development environment.

**Figure 10. STM8AF5288T block diagram**



### 4.2.2 STM8AF board LEDs

The STM8AF board includes the following LEDs:

- LD1 COM: LD1 default status is red. LD1 turns to green to indicate that communications are in progress between the PC and the ST-LINK/V2.
- LD2 PWR: red LED indicates that the board is powered and that 5 V is output from L99PM62GXP power management IC.
- User LD3: red LED is a user LED connected to the I/O PA3 of the STM8AF5288T.
- User LD4: green LED is a user LED connected to the I/O PD3 of the STM8AF5288T.
- User LD5: green LED is a user LED connected to the I/O PD0 of the STM8AF5288T.
- User LD6: green LED is a user LED connected to the I/O PE3 of the STM8AF5288T.
- User LD7: green LED is a user LED connected to the I/O PC3 of the STM8AF5288T.

### 4.2.3 STM8AF board Push buttons

STM8AF board includes two push buttons:

- USER1: User button connected to the I/O PE2 of STM8AF5288T.
- USER2: User button connected to the I/O PE1 of STM8AF5288T.

### 4.2.4 STM8AF board solder bridges

**Table 2. STM8AF board solder bridges**

| Bridge | State(1) | Description |
|---|---|---|
| SB1 (Reserved) | **ON** | Reserved, do not modify. |
| SB2 (STM_RST) | **OFF** | NRST signal of STM32F103C8T6 (ST-LINK/V2) is not connected to GND. |
| | ON | NRST signal of STM32F103C8T6 (ST-LINK/V2) is connected to GND. |
| SB3 (MCO) | **OFF** | MCO clock from STM32F103C8T6 is not connected to PA1 (OSC_IN) of STM8AF5288T. |
| | ON | MCO clock from STM32F103C8T6 is connected to PA1 (OSC_IN) of STM8AF5288T. |
| SB4,5 (Reserved) | **OFF** | Reserved, do not modify. |
| SB6 (L99PM62GXP Reset) | **OFF** | NRESET of L99PM62GXP is not connected to the STM8AF5288T Reset pin (external watchdog disable). |
| | ON | NRESET of L99PM62GXP is connected to the STM8AF5288T Reset pin (external watchdog enable). |
| SB7 (CAN supply) | **ON** | CAN transceiver is powered ON. |
| | OFF | CAN transceiver is OFF. This selection saves power consumption. |
| SB8 (Start-up delay) | **OFF** | If the STM8AF board is connected to another STM8AF board, then one of them must have SB8 OFF. |
| | ON | The STM8AF board is connected to the STM8AL board (standard demo package). |
| SB9 (CAN terminating resistor) | **ON** | The CAN terminating 120 Ohms resistor is connected on the CAN bus. |
| | OFF | The CAN terminating 120 Ohms resistor is not connected on the CAN bus. |
| SB10,11 (USB5V) | **ON** | USB5V is available on CN3/CN4 connectors for powering an external board through CN3/CN4. |
| | OFF | USB5V is not available on CN3/CN4 connectors. |
| SB12,13 (Reserved) | **ON** | Reserved, do not modify. |

1. Default SBx state is shown in bold.

### 4.2.5 STM8AF board jumpers selection

Table 3. STM8AF board jumper selection

| Jumper | State[1] | Description |
|---|---|---|
| JP1 (LIN/FLASH) | 1-2 | Flash mode selected [2]. |
| | **2-3** | LIN communication enabled. |
| JP2 (CAN/FLASH) | **1-2** | Flash mode selected [2]. |
| | 2-3 | CAN communication enabled. |
| JP3 ($I_{DD}$) | **ON** | Standard operation, 5 V connected to the $V_{DD}$ of the microcontroller. |
| | OFF | An ammeter can be connected between JP3 pins to measure the current sunk by the MCU. |
| JP4 (Reserved) | **OFF** | Reserved, do not modify. |

1. Default jumper state is shown in bold.
2. The Flash mode is activated if at least JP1 or JP2 selects Flash mode.

### 4.2.6 STM8AF board extension connection

Male headers P1, P2 and P3 connectors can connect the STM8AF board to a standard prototyping/wrapping board. Free GPI/Os of the STM8AF5288T are available on P1 and P2. L99PM62GXP device I/Os are connected to P3. P1, P2 and P3 can also be probed by an oscilloscope, a logic analyzer or a voltmeter.

P1 connector contains the full port B GPI/Os and the alternate functions are the first 8 ADC channel inputs. Its standard HE10 format complies with some additional modules or resources that are pin-to-pin equivalent.

Table 4. STM8AF board P1 pinout microcontroller connectivity

| Pin number P1 | Pin number STM8AF MCU | Board pin name | Type | Main function | Alternate function |
|---|---|---|---|---|---|
| 1 | 22 | PB0 | I/O | Port B0 | Analog input AIN0 |
| 2 | 21 | PB1 | I/O | Port B1 | Analog input AIN1 |
| 3 | 20 | PB2 | I/O | Port B2 | Analog input AIN2 |
| 4 | 19 | PB3 | I/O | Port B3 | Analog input AIN3 |
| 5 | 18 | PB4 | I/O | Port B4 | Analog input AIN4 |
| 6 | 17 | PB5 | I/O | Port B5 | Analog input AIN5 |
| 7 | 16 | PB6 | I/O | Port B6 | Analog input AIN6 |
| 8 | 15 | PB7 | I/O | Port B7 | Analog input AIN7 |
| 9 | | $V_{DD}$ | | Microcontroller Digital power supply | |
| 10 | | GND | | Digital ground | |

Table 5. STM8AF board P2 pinout microcontroller connectivity

| Pin number P2 | Pin number STM8AF MCU | Board pin name | Type | Main function | Alternate function |
|---|---|---|---|---|---|
| 1 | | GND | | Digital ground | |
| 2 | 1 | NRST | I/O | Reset | |
| 3 | 48 | PD7 | I/O | Port D7 | TLI |
| 4 | 45 | PD4 | I/O | Port D4 | Timer 2 - channel 1 |
| 5 | 43 | PD2 | I/O | Port D2 | Timer 3 - channel 1 |
| 6 | 12 | PA6 | I/O | Port A6 | USART synchronous clock |
| 7 | 40 | PE0 | I/O | Port E0 | CCO Configurable clock output |
| 8 | 24 | PE6 | I/O | Port E6 | Analog input AIN9 |
| 9 | 29 | PC4 | I/O | Port C4 | Timer 1 - channel 4 |
| 10 | 27 | PC2 | I/O | Port C2 | Timer 1 - channel 2 |
| 11 | 26 | PC1 | I/O | Port C1 | Timer 1 - channel 1 |
| 12 | | $V_{DD}$ | | Microcontroller Digital power supply | |

Table 6. STM8AF board P3 pinout L99PM62GXP connectivity(1)

| Pin number P3 | Pin number STM8AF MCU | Board pin name | Type | Main function |
|---|---|---|---|---|
| 1 | | 5V | | 5 V board power supply (output 5V1 from L99PM62GXP) |
| 2 | 20 | WU1 | I | Wake-up input 1 |
| 3 | 28 | OUT2 | O | High-side driver output (7 Ω, typ.) |
| 4 | 29 | OUT1 | O | High-side driver output (7 Ω, typ.) |
| 5 | 30 | O_HS | O | High-side driver (1 Ω, typ.) |
| 6 | 34 | REL1 | O | Low-side driver output (2 Ω typ.) |
| 7 | 35 | REL2 | O | Low-side driver output (2 Ω typ.) |
| 8 | | GND | | Digital ground |
| 9 | | $V_{BAT}$ | I | External power supply (12 Vdc typ.) |

1. For additional information on L99PM62GXP device connectivity, please refer to product datasheet available at www.st.com.

## 4.3 STM8AL board dedicated resources

The STM8AL board is designed around the STM8AL3L68T microcontroller in a 48-pin LQFP package.

*Figure 11* illustrates the connections between the STM8AL3L68T and the different peripherals (ST-LINK/V2, L99PM62GXP IC, push buttons, LED, $I_{DD}$ measurement circuitry, LCD and connectors).

*Figure 11* and *Figure 12* help you to locate these features on the STM8AL board.

**Figure 11. STM8AL board hardware block diagram**

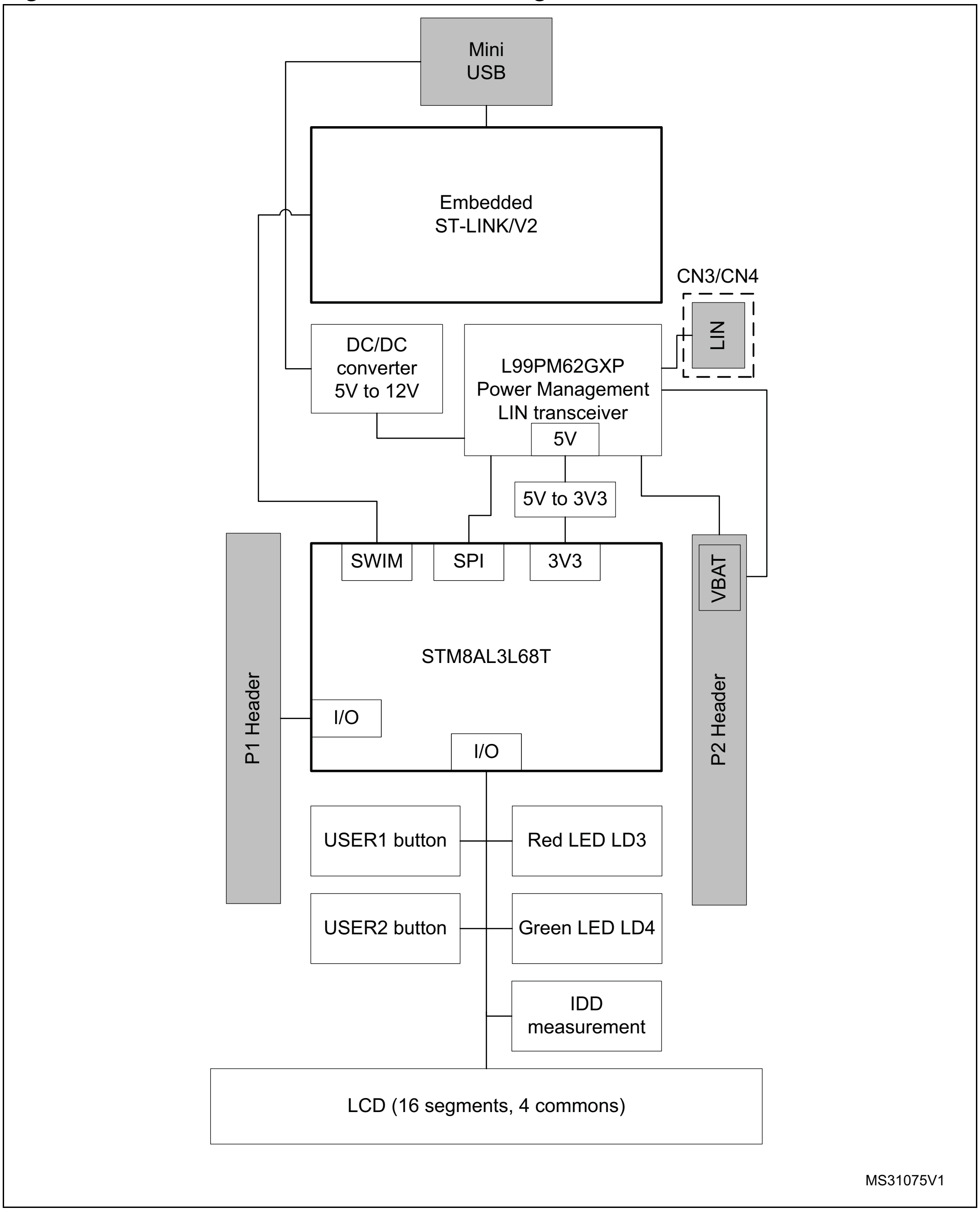


**Figure 12. STM8AL board top layout**

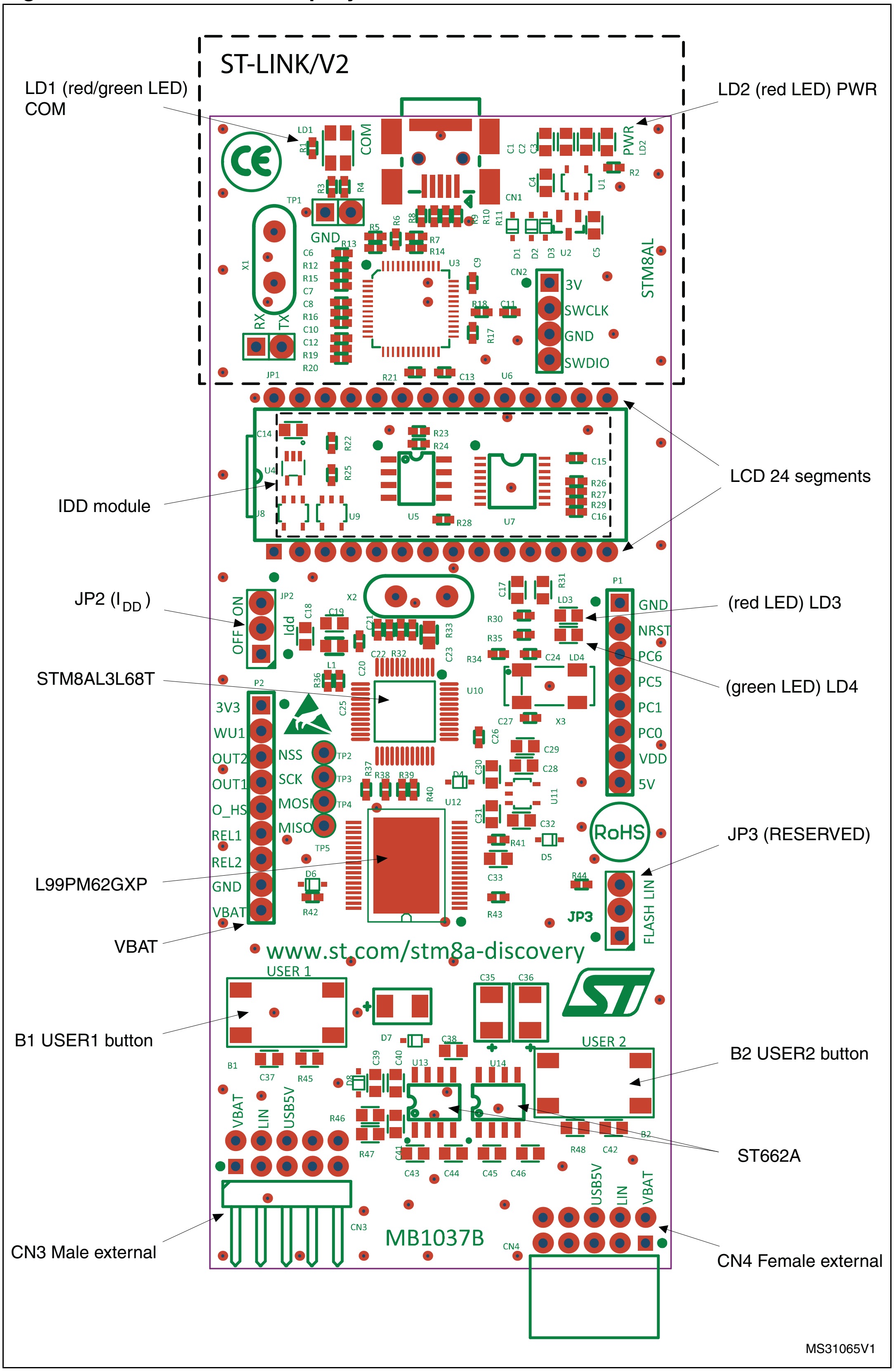
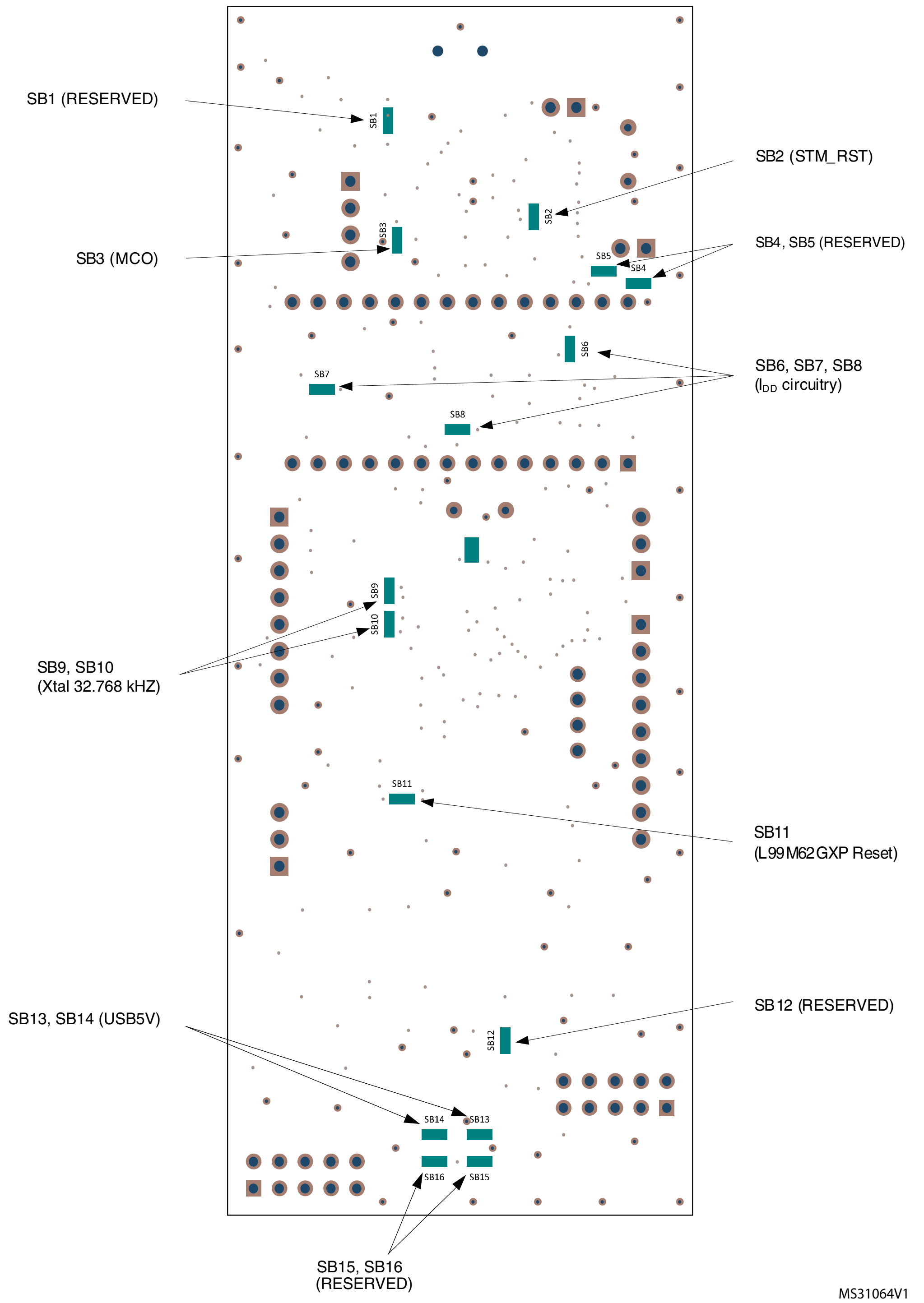


Figure 13. STM8AL board bottom layout

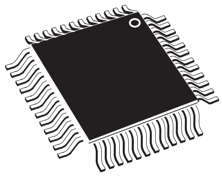


### 4.3.1 STM8AL3L68T microcontroller

This automotive 8-bit ultralow power MCU has 32 Kbytes Flash, 1 Kbytes data EEPROM, RTC, LCD, timers, USART, I2C, SPI, ADC, DAC and comparators.

**Figure 14. STM8AL3L68T package**

STM8AL3L68T



LQFP48 7x7

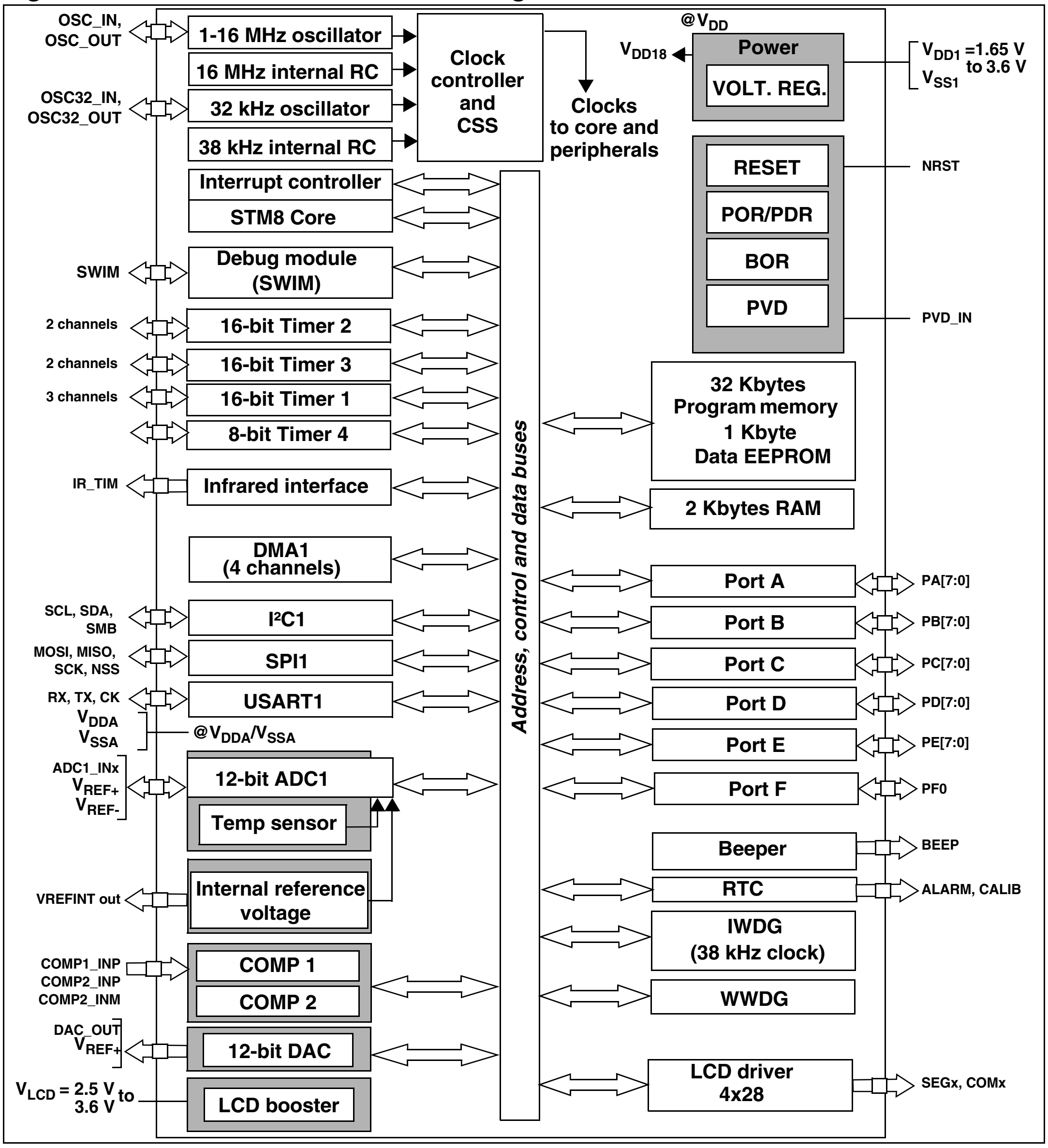
32 Kbytes of Flash memory
1 Kbytes of EEPROM
2 Kbytes of RAM

This microcontroller belongs to the STM8AL family and provides the following benefits:

- Integrated system
  - Up to 32 Kbytes of medium-density embedded Flash program memory
  - 1 Kbyte of data EEPROM
  - Internal high speed and low-power low speed RC.
  - Embedded reset
- Ultralow power consumption
  - 195 µA/MHZ + 440 µA (consumption)
  - 0.9 µA with LSI in Active-halt mode
  - Clock gated system and optimized power management
  - Capability to execute from RAM for Low power wait mode and Low power run mode
- Advanced features
  - Up to 16 MIPS at 16 MHz CPU clock frequency
  - Direct memory access (DMA) for memory-to-memory or peripheral-to-memory access.
- Short development cycles
  - Application scalability across a common family product architecture with compatible pinout, memory map and modular peripherals.
  - Wide choice of development tools

This device offers 12-bit ADC, DAC, two comparators, real-time clock, three 16-bit timers, one 8-bit timer as well as standard communication interfaces such as SPI, I2C and USART. A 4x28-segment LCD is available on the medium-density STM8AL3L68T device.

## Figure 15. STM8AL3L68T MCU block diagram




1. Legend:
   ADC: Analog-to-Digital Converter
   BOR: Brownout Reset
   DMA: Direct Memory Access
   DAC: Digital-to-Analog Converter
   I²C: Inter-Integrated Circuit multimaster interface
   IWDG: Independent WatchDoG
   LCD: Liquid Crystal Display
   POR/PDR: Power On Reset / Power Down Reset
   RTC: Real-Time Clock
   SPI: Serial Peripheral Interface
   SWIM: Single Wire Interface Module
   USART: Universal Synchronous Asynchronous Receiver Transmitter
   WWDG: Window WatchDoG

### 4.3.2 STM8AL board LEDs

The STM8AL board includes the following LEDs and their description is:

LD1 COM: LD1 default status is red. LD1 turns to green to indicate that communications are in progress between the PC and the ST-LINK/V2.

LD2 PWR: red LED indicates that the board is powered and that 3.3 V is generated by the regulator supplied by the L99PM62GXP power management IC.

User LD3: red LED is a user LED connected to the I/O PE7 of the STM8AL3L68T.

User LD4: green LED is a user LED connected to the I/O PC7 of the STM8AL3L68T.

### 4.3.3 STM8AL board Push buttons

The STM8AL board includes two push buttons:

- USER1: User button connected to the I/O PE1 of STM8AL3L68T.
- USER2: User button connected to the I/O PE2 of STM8AL3L68T.

### 4.3.4 STM8AL board built-in $I_{DD}$ measurement circuit

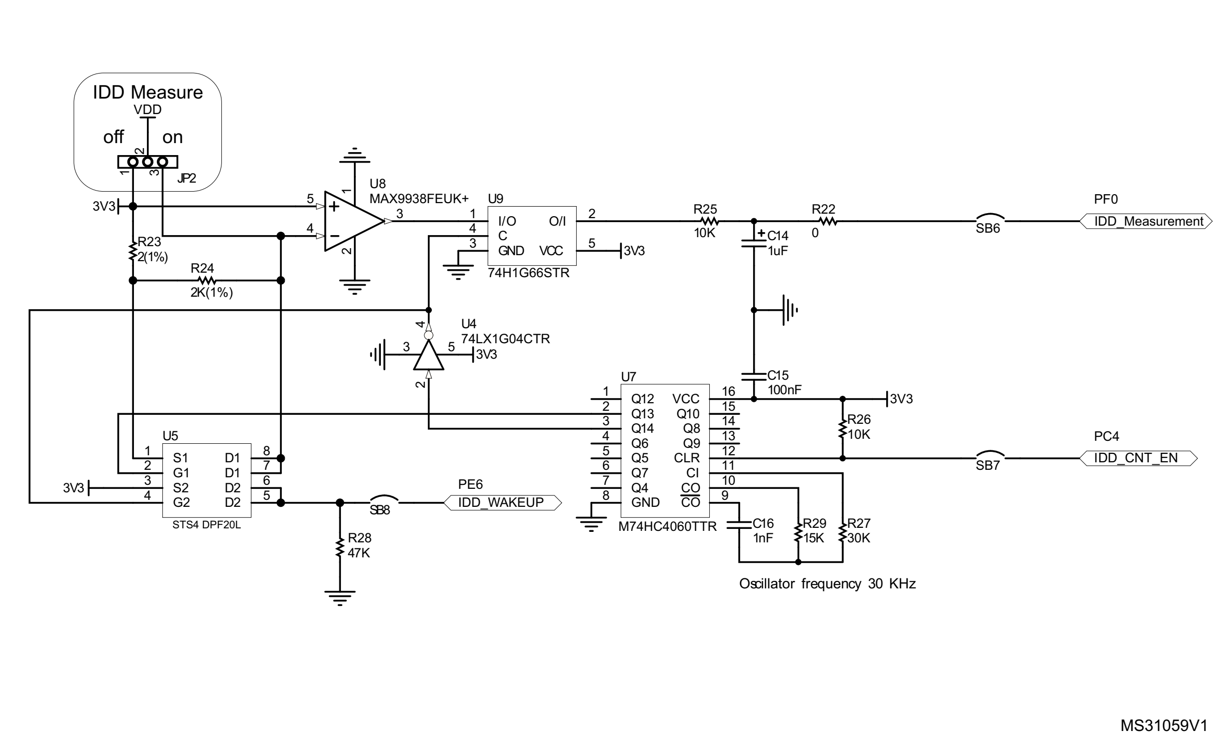
The STM8AL board built-in $I_{DD}$ measurement circuit allows the consumption of the STM8AL3L68T to be measured and displayed on the LCD Glass while the MCU is in Run or Low power saving modes.

- JP2 in ON position: STM8AL3L68T is powered through $I_{DD}$ measurement circuit (default).
- JP2 in OFF position: STM8AL3L68T is powered directly by +3V3, $I_{DD}$ measurement circuit is bypassed.

Note: When jumper JP2 is removed the current consumption of the STM8AL3L68T can be measured by connecting an ammeter between jumper JP2 pin 1 and pin 2.

For $I_{DD}$ measurement by the MCU itself, the circuit below is implemented on the STM8AL board. Solder bridges SB6, SB7 and SB8 must be closed and a jumper must be plugged between JP2 pin 2 and pin 3.

**Figure 16. STM8AL board $I_{DD}$ measurement circuit**




- Run mode

In Run mode, $I_{DD}$ current is measured using the operational amplifier MAX9938FEUK+ (U8) connected to the 2 Ω shunt resistor (R23). In this case IDD_CNT_EN remains high during measurement, so R24 remains in short-circuit during the measurement because of switch U5 which remains ON permanently. The jumper JP2 must be connected between pins 2 and 3 of JP2. The measurement range in this case can be up to 30 mA.

- Low power mode

In Low power modes (Halt or Active halt), $I_{DD}$ current is measured using the operational amplifier MAX9938FEUK+ (U8) connected to the 2 KΩ shunt resistor (R24), controlled by the switch STS4DPF20L (U5). In this case the counter 74HC4060 (U7) enabled by IDD_CNT_EN manages the measurement timing according to *Figure 17*. The measurement range in this case can be up to 30 µA.

- Low power mode $I_{DD}$ measurement principle

The principle used to measure a current when the STM8AL3L68T is in Low power mode is:

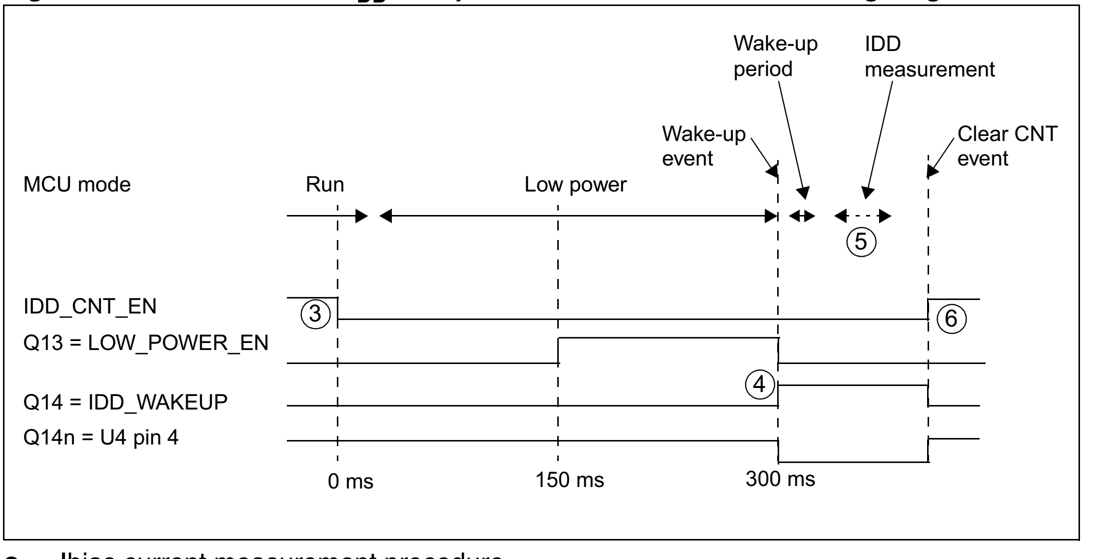
1. Configure ADC to measure voltage on the IDD_Measurement pin.
2. Configure PE6 to serve as wakeup pin.
3. Enter Low power mode after setting IDD_CNT_EN (PC4) signal low.
4. IDD_WAKEUP rising edge wakes up the MCU after around 300 ms.
5. Start ADC conversion as soon as possible after wakeup in order to measure the voltage corresponding to Low power mode on capacitor C14.
6. Reset the counter by programming IDD_CNT_EN high (in less than 70 ms after the wakeup) to avoid the R24 2 KΩ resistor being connected later in Run mode.

The measurement timing is given in *Figure 17*. In Low power modes, the 2 KΩ resistor is connected when the U5 switch goes off after entering Low power mode. The Q13 output of the counter allows connection of the 2 KΩ resistor when the current $I_{DD}$ becomes very low.

*Figure 17* shows how the counter and U5 ensure that, 150 ms after IDD_CNT_EN falling edge, the shunt resistor R24 is connected between VDD_MCU and the power supply in order to reduce the measurement range to 30 µA full scale (instead of 30 mA in Run mode).

Then after another 150 ms for current stabilization, R24 is shorted, the $I_{DD}$ measurement is stored in C14, and the MCU is woken up. After wakeup, the MCU can measure the $I_{DD}$ current corresponding to the Low power mode stored in C14.

**Figure 17. STM8AL board $I_{DD}$ Low power mode measurement timing diagram**




- Ibias current measurement procedure

In Low power mode the bias current of operational amplifier input (U8 pin 4) is not negligible compared to $I_{DD}$ current (typical Ibias is ~240 nA). To obtain a reliable STM8AL3L68T $I_{DD}$ measurement, it is mandatory to subtract the bias current from the $I_{DD}$ low power measurement since MCU is not sinking the current. Ibias is measured during production test and stored in the MCU EPROM. The demonstration software, Discover, uses this value to display the correct $I_{DD}$. The Ibias measurement procedure is part of the demonstration software and can be launched if required.

The procedure for Ibias measurement (implemented in the package demo) is:

1. Power off the board (disconnect the USB cable).
2. Set jumper JP2 to OFF position (pins 1 and 2).
3. Push down USER2 button while powering on the board from the USB.
4. Wait at least 1 second before releasing USER2, the LCD displays the Ibias measurement.
5. Power off the board (disconnect the USB cable).
6. Set jumper JP2 to ON position (pins 2 and 3). The Ibias value is now stored. The bias current is then subtracted from the $I_{DD}$ measurement performed in Low power mode.

### 4.3.5 STM8AL board LCD (16 segments, 4 commons)

This LCD allows the STM8AL3L68T to display any information on four 14-segment digits and 4 BARs, using all COMs. (See the LCD segment mapping in *Figure 18* and pin connections in *Table 7*). The two first left digits of the LCD display are not used in this application.

Characteristics overview:

- 16 segments and 4 commons
- Drive method: multiplexed 1/4 duty, 1/3 bias
- Operating voltage: 3 V
- Operating temperature: 0 to 50°C
- Connector: 28-pin DIL 2.54 mm pitch

*Note: When the LCD is plugged in, all I/O ports listed in Table 7 are unavailable. To use one of these as I/O, you must remove the LCD*

**Figure 18. LCD segment mapping**

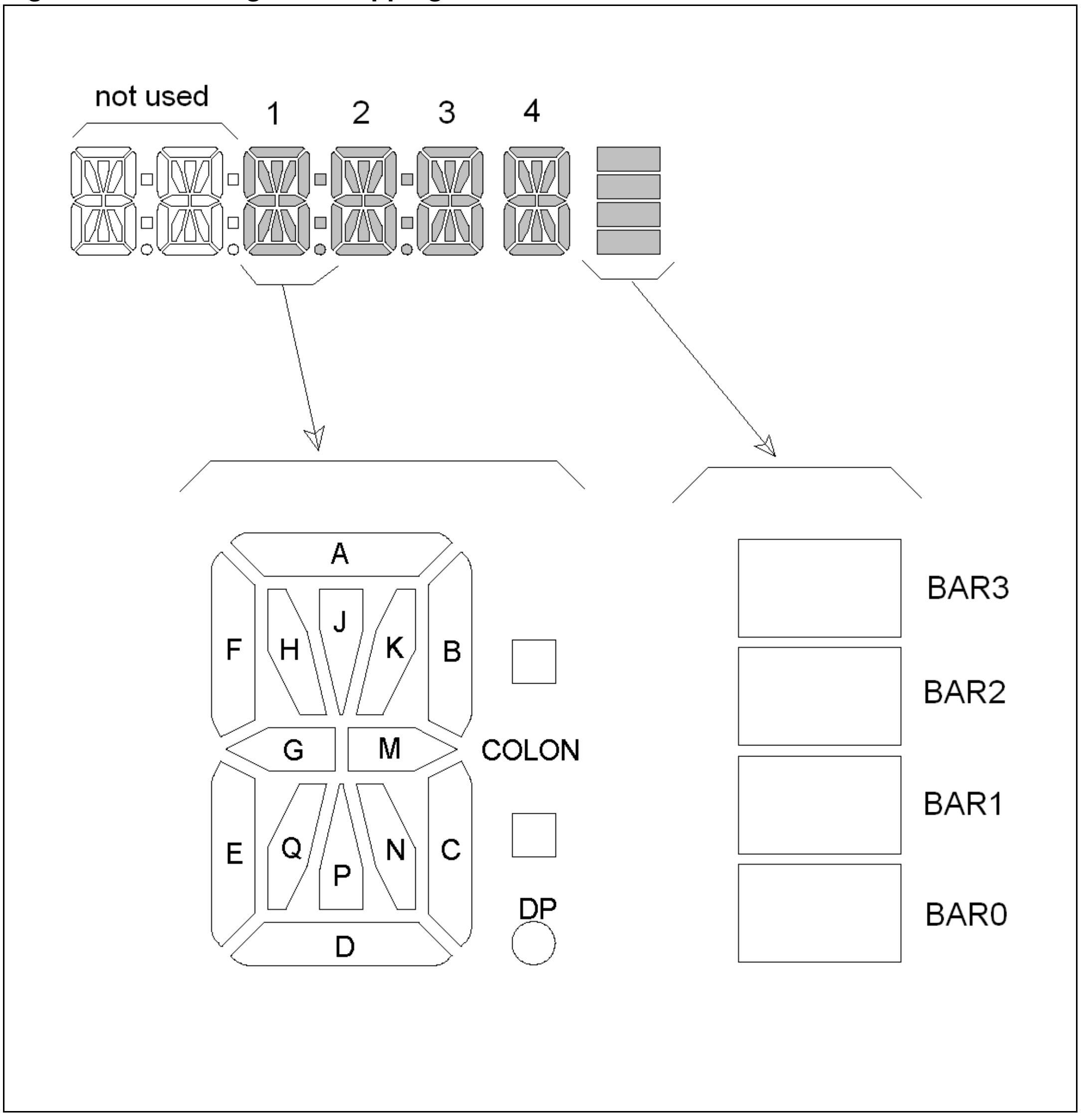


**Table 7. LCD connections**

| STM8AL3L68T | LCD | | | | |
|---|---|---|---|---|---|
| **Pin Name** | **PIN** | **COM3** | **COM2** | **COM1** | **COM0** |
| | 1 | 1N | 1P | 1D | 1E |
| | 2 | 1DP | 1COLON | 1C | 1M |
| | 3 | 2N | 2P | 2D | 2E |
| | 4 | 2DP | 2COLON | 2C | 2M |
| PE3_LCDSEG4 | 5 | 3N | 3P | 3D | 3E |
| PE4_LCDSEG5 | 6 | 3DP | 3COLON | 3C | 3M |
| PE5_LCDSEG6 | 7 | 4N | 4P | 4D | 4E |
| PD0_LCDSEG7 | 8 | 4DP | 4COLON | 4C | 4M |
| PD2_LCDSEG8 | 9 | 5N | 5P | 5D | 5E |
| PD3_LCDSEG9 | 10 | BAR2 | BAR3 | 5C | 5M |
| PB0_LCDSEG10 | 11 | 6N | 6P | 6D | 6E |
| PB1_LCDSEG11 | 12 | BAR0 | BAR1 | 6C | 6M |
| PD1_LCDCOM3 | 13 | COM3 | | | |
| PA6_LCDCOM2 | 14 | | COM2 | | |
| PA5_LCDCOM1 | 15 | | | COM1 | |
| PA4_LCDCOM0 | 16 | | | | COM0 |
| PB2_LCDSEG12 | 17 | 6J | 6K | 6A | 6B |
| PB3_LCDSEG13 | 18 | 6H | 6Q | 6F | 6G |
| PA7_LCDSEG0 | 19 | 5J | 5K | 5A | 5B |
| PE0_LCDSEG1 | 20 | 5H | 5Q | 5F | 5G |
| PD6_LCDSEG20 | 21 | 4J | 4K | 4A | 4B |
| PD7_LCDSEG21 | 22 | 4H | 4Q | 4F | 4G |
| PD4_LCDSEG18 | 23 | 3J | 3K | 3A | 3B |
| PD5_LCDSEG19 | 24 | 3H | 3Q | 3F | 3G |
| | 25 | 2J | 2K | 2A | 2B |
| | 26 | 2H | 2Q | 2F | 2G |
| | 27 | 1J | 1K | 1A | 1B |
| | 28 | 1H | 1Q | 1F | 1G |

### 4.3.6 STM8AL board solder bridges

Table 8. STM8AL board solder bridges

| Bridge | State | Description |
|---|---|---|
| SB1 (Reserved) | **ON** | Reserved, do not modify. |
| SB2 (STM_RST) | **OFF** | NRST signal of STM32F103C8T6 (ST-LINK/V2) is not connected to GND. |
| | ON | NRST signal of STM32F103C8T6 (ST-LINK/V2) is connected to GND. |
| SB3 (MCO) | **OFF** | MCO clock from STM32F103C8T6 is not connected to PA2 (OSC_IN) of STM8AL3L68T. |
| | ON | MCO clock from STM32F103C8T6 is connected to PA2 (OSC_IN) of STM8AL3L68T. |
| SB4, 5 (Reserved) | **OFF** | Reserved, do not modify. |
| SB6, 7, 8 ($I_{DD}$ circuitry) | **ON** | $I_{DD}$ measurement circuitry and features connected. |
| | OFF | $I_{DD}$ measurement circuitry and features are not connected (freeing PF0, PC4 and PE6). |
| SB9, 10 (Xtal 32.768 kHz) | **OFF** | PC5 and PC6 of STM8AL3L68T are free for general purpose I/Os. |
| | ON | PC5 and PC6 of STM8AL3L68T are connected to 32.768 kHz crystal oscillator (if fitted on board). |
| SB11 (L99PM62GXP Reset) | **OFF** | NRESET of L99PM62GXP is not connected to STM8AL3L68T Reset pin (external watchdog disable). |
| | ON | NRESET of L99PM62GXP is connected to STM8AL3L68T Reset pin (external watchdog enable). |
| SB12 (Reserved) | **ON** | Reserved, do not modify. |
| SB13, 14 (USB5V) | **ON** | USB5V is distributed on CN3/CN4 connectors (USB5V can drive an external board connected to CN3 and CN4). |
| | OFF | USB5V is not distributed on CN3/CN4 connectors. |
| SB15, 16 (Reserved) | **ON** | Reserved, do not modify. |

1. Default SBx state is shown in bold.

### 4.3.7 STM8AL board jumpers selection

Table 9. STM8AL board jumpers selection

| Jumper | State(1) | Description |
|---|---|---|
| JP1 (Reserved) | **OFF** | Reserved, do not modify. |
| JP2 ($I_{DD}$) | 1-2 OFF | Ibias measurement selection. |
| | **2-3 ON** | $I_{DD}$ measurement selection. |
| JP3 (Reserved) | **2-3** | Reserved, do not modify. |

1. Default jumper state is shown in bold.

### 4.3.8 STM8AL board extension connection

Male headers P1 and P2 connectors can connect the STM8AL board to a standard prototyping/wrapping board. Free GPI/Os of STM8AL3L68T are available on P1. L99PM62GXP device I/Os are connected to P2.

P1 and P2 can also be probed by an oscilloscope, a logic analyzer or a voltmeter.

**Table 10. STM8AL board P1 pinout Microcontroller connectivity**

| Pin number P1 | Pin number STM8AL MCU | Board pin name | Type | Main function | Alternate function |
|---|---|---|---|---|---|
| 1 | | GND | | Digital ground | |
| 2 | 2 | NRST | I/O | Reset | PA1 |
| 3 | 45 | PC6 | I/O | Port C6 | OSC32_OUT |
| 4 | 44 | PC5 | I/O | Port C5 | OSC32_IN |
| 5 | 38 | PC1 | I/O | Port C1 | I2C1_SCL |
| 6 | 37 | PC0 | I/O | Port C0 | I2C1_SDA |
| 7 | 10 | $V_{DD}$ | | Microcontroller Digital power supply | |
| 8 | | 5V | | 5V board power supply (output 5V1 from L99PM62GXP) | |

**Table 11. STM8AL board P2 pinout L99PM62GXP connectivity(1)**

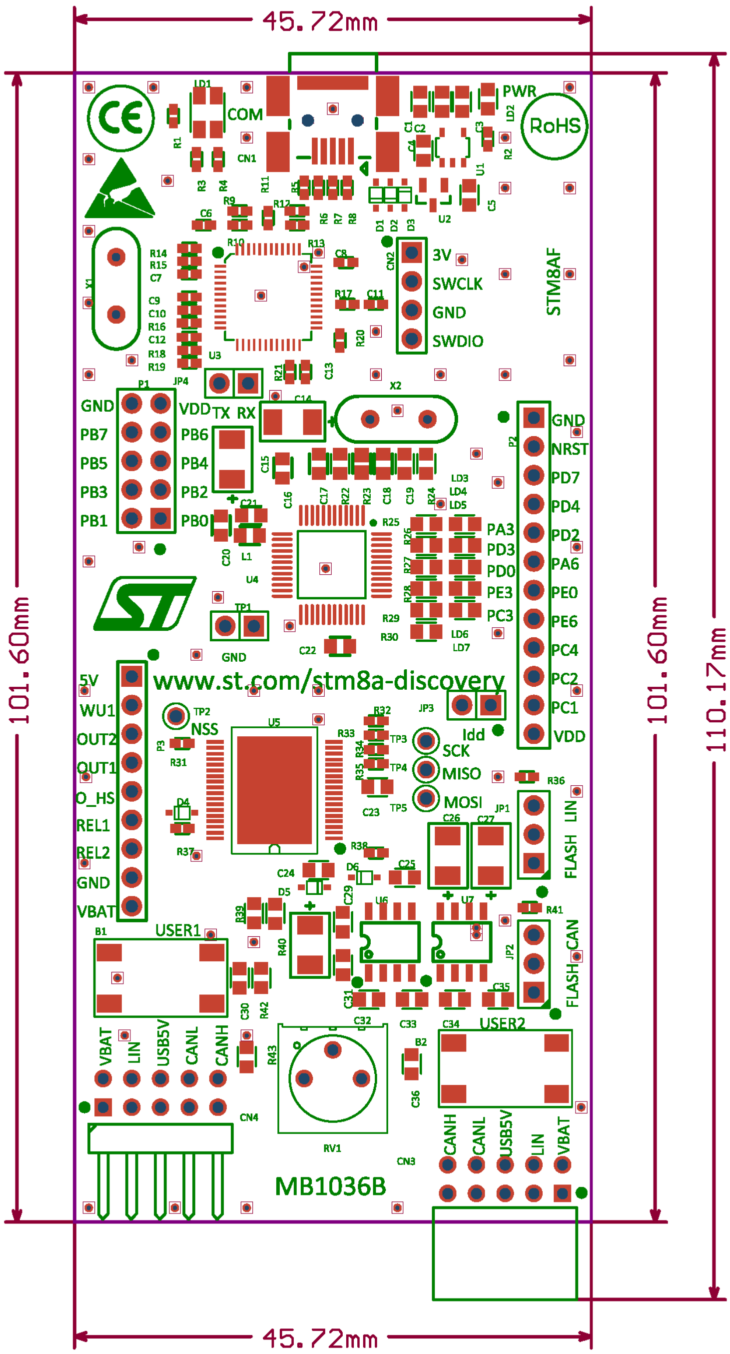
| Pin number P2 | Pin number L99PM62GXP | Board pin name | Type | Main function |
|---|---|---|---|---|
| 1 | | 3V3 | | 3.3 V board power supply (output 3.3 V from U11 PWR_STM8) |
| 2 | 20 | WU1 | I | Wake-up input 1 |
| 3 | 28 | OUT2 | O | High-side driver output (7 Ω, typ.) |
| 4 | 29 | OUT1 | O | High-side driver output (7 Ω, typ.) |
| 5 | 30 | O_HS | O | High-side driver (1 Ω, typ.) |
| 6 | 34 | REL1 | O | Low-side driver output (2 Ω typ.) |
| 7 | 35 | REL2 | O | Low-side driver output (2 Ω typ.) |
| 8 | | GND | | Digital ground |
| 9 | | VBAT | I | External power supply (12Vdc typ.) |

1. For additional information on L99PM62GXP device connectivity, please refer to product datasheet available at www.st.com.

# 5 STM8A-DISCOVERY boards mechanical drawing

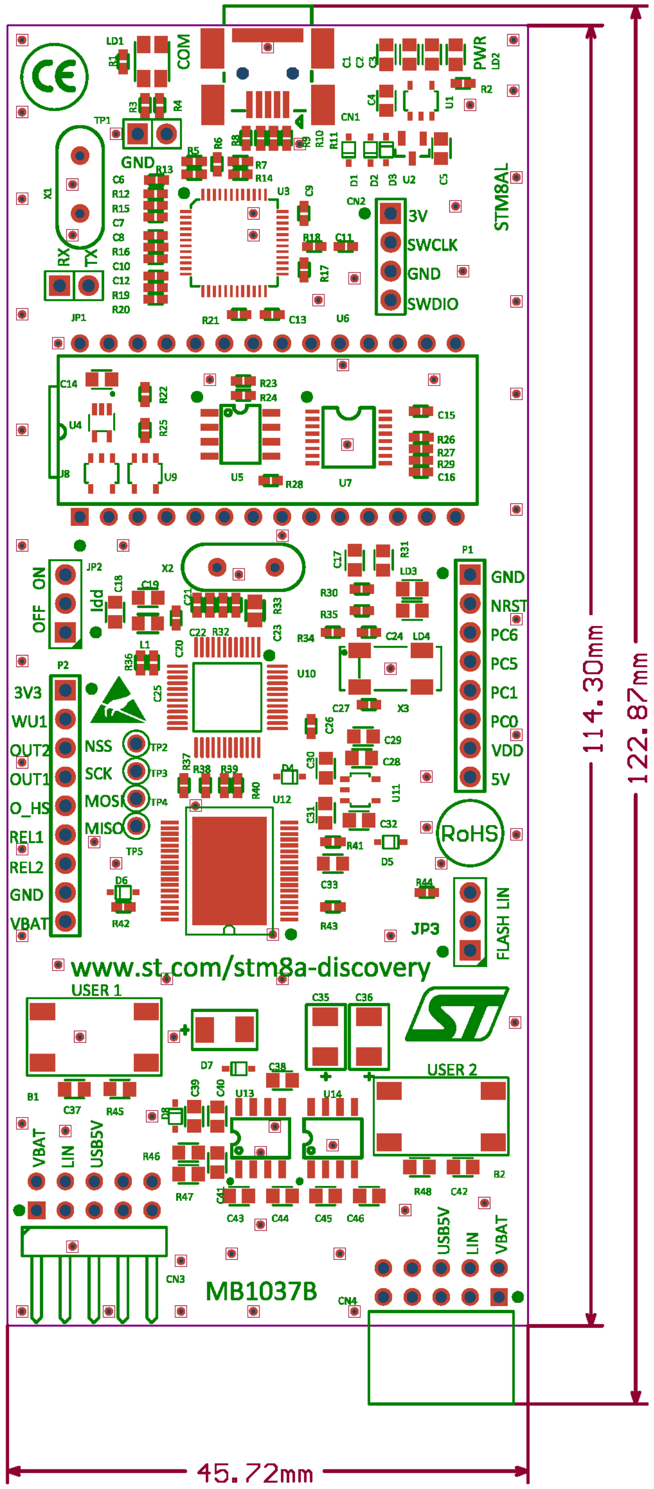
## 5.1 STM8AF board mechanical drawing

**Figure 19. STM8AF board mechanical drawing**



## 5.2 STM8AL board mechanical drawing

**Figure 20. STM8AL board mechanical drawing**



# 6 STM8AF board electrical schematics

**Figure 21. STM8AF board top level**

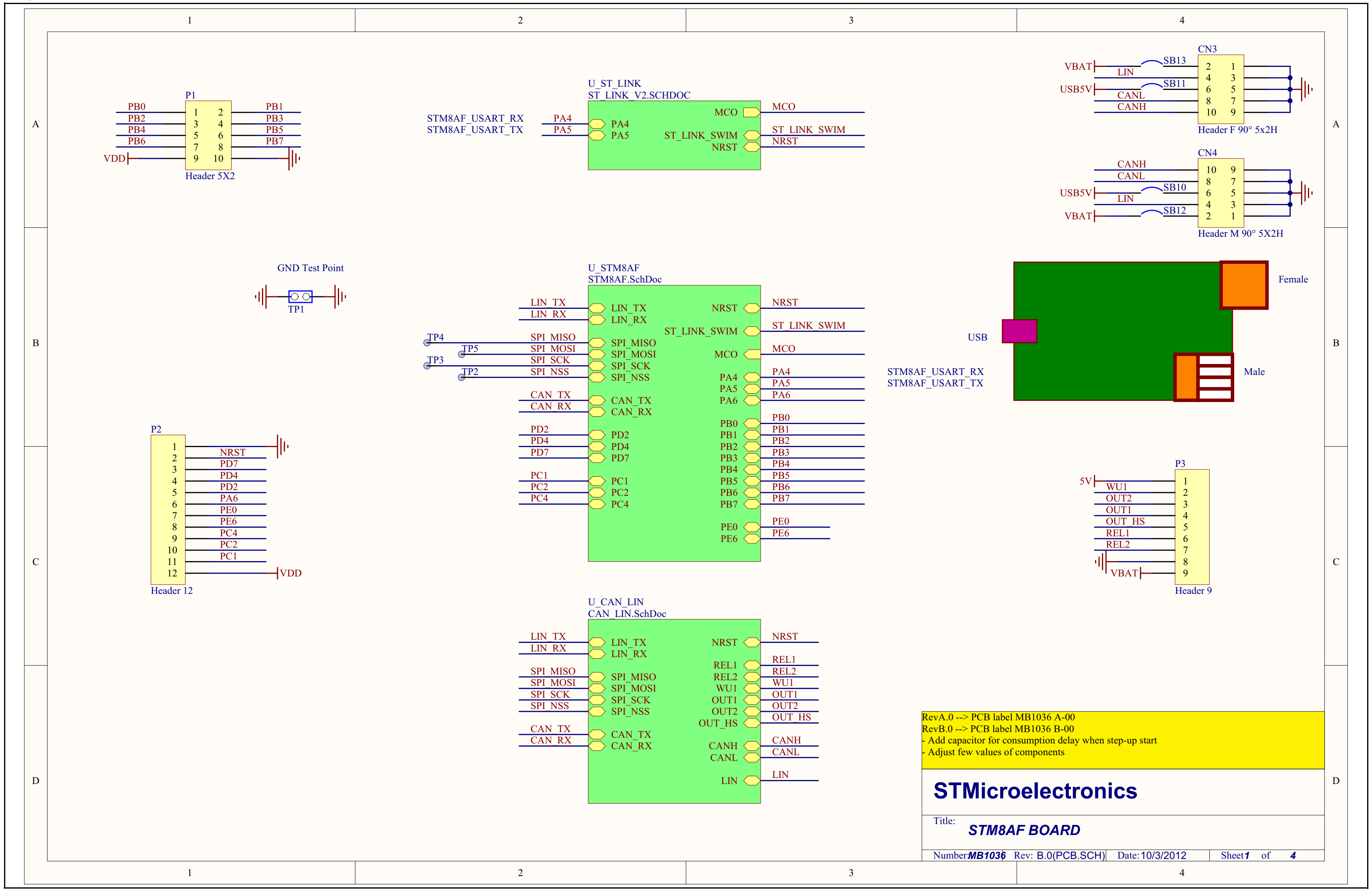
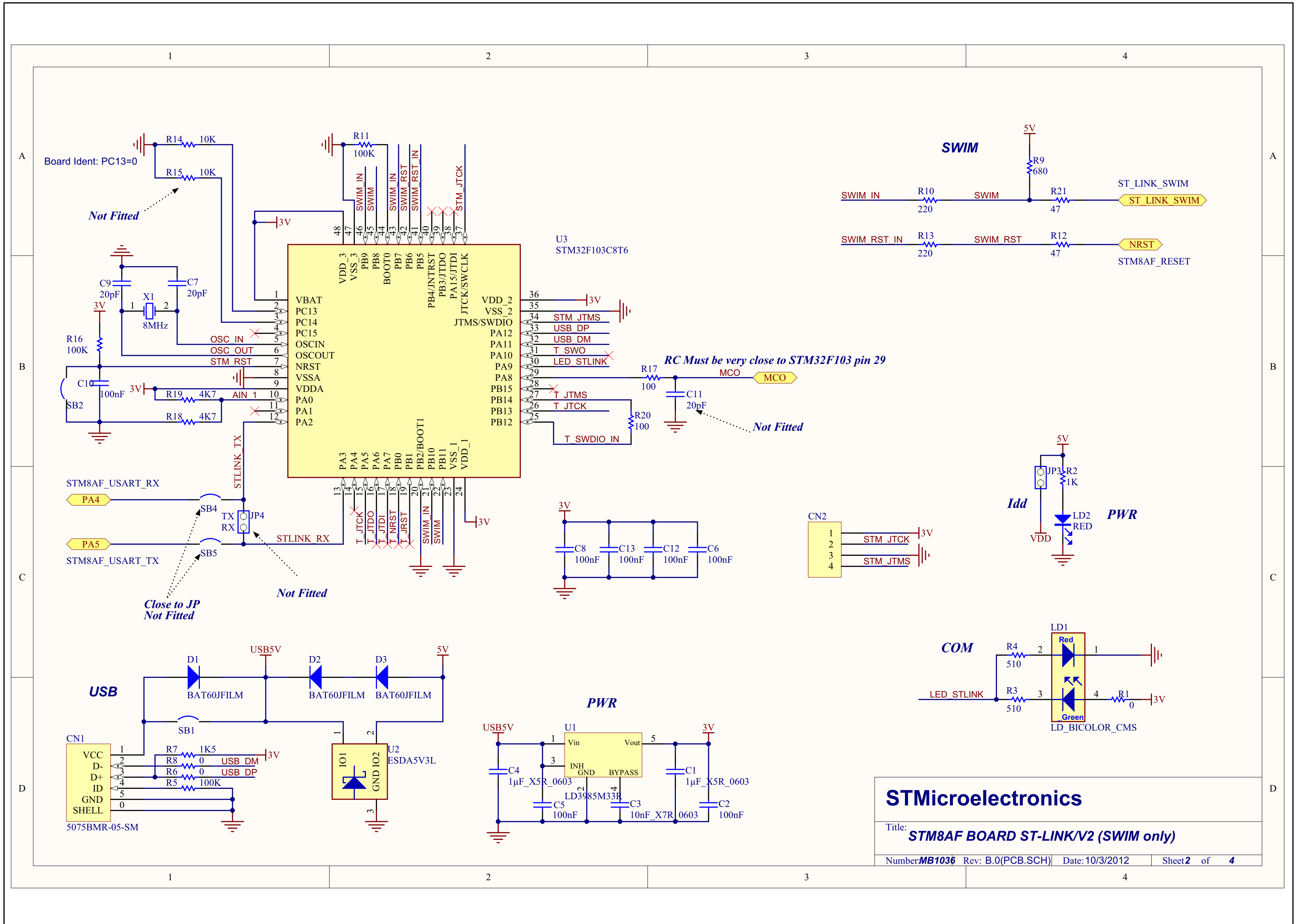
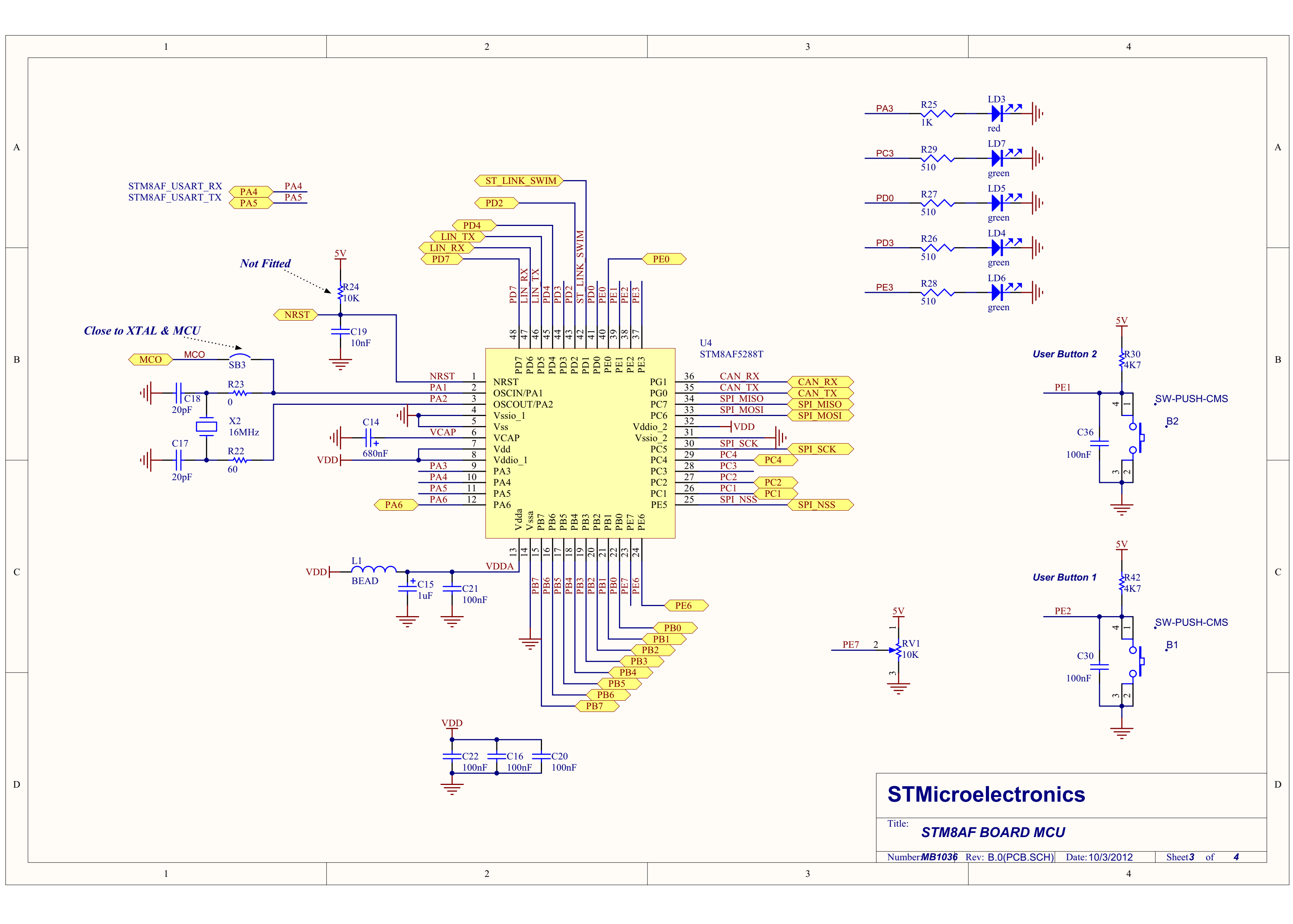


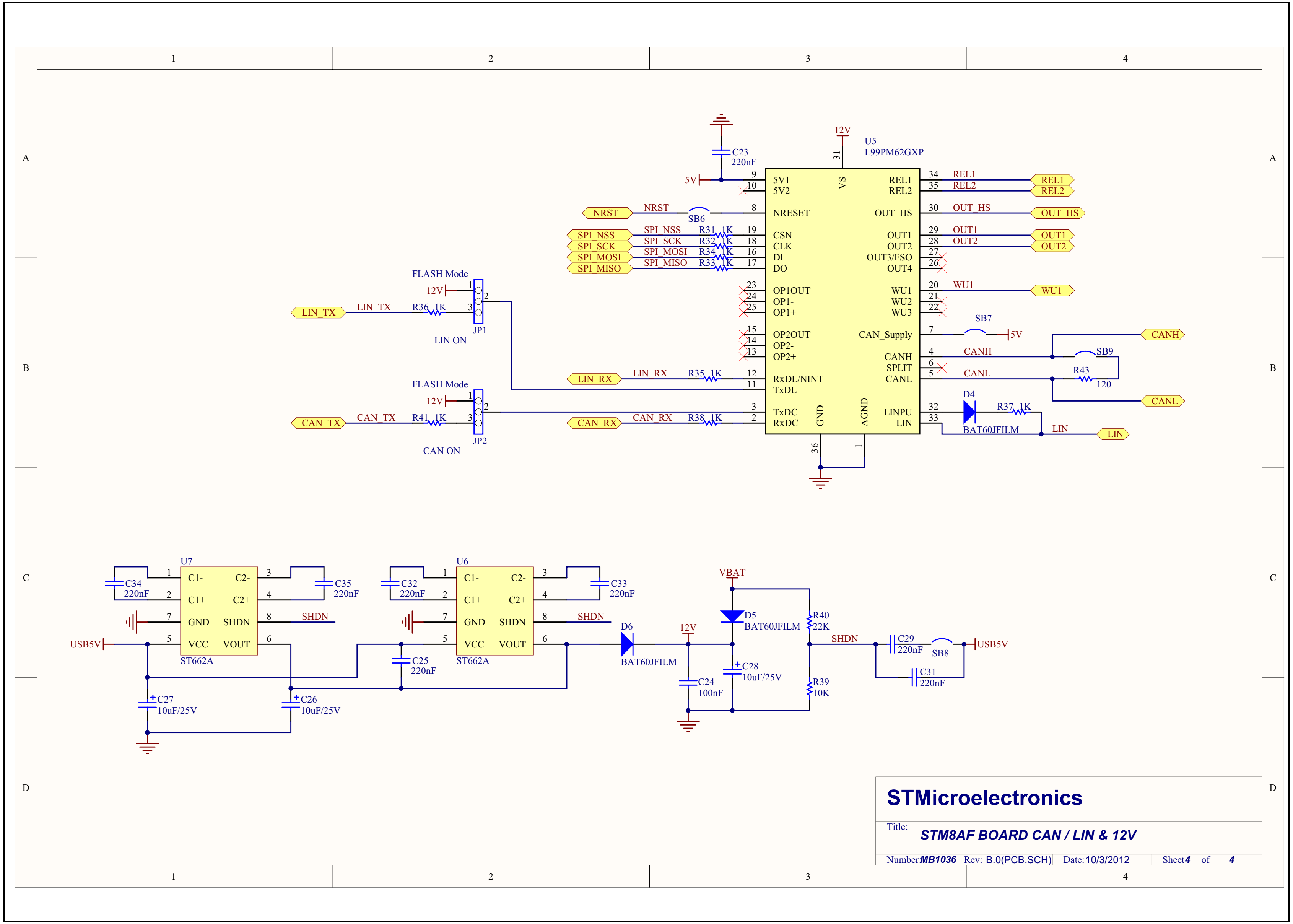
**Figure 22. STM8AF board ST-LINK/V2 (SWIM only)**



## Figure 23. STM8AF board MCU



### Figure 24. STM8AF board CAN/LIN and 12V



# 7 STM8AL board electrical schematics

**Figure 25. STM8AL board top level**

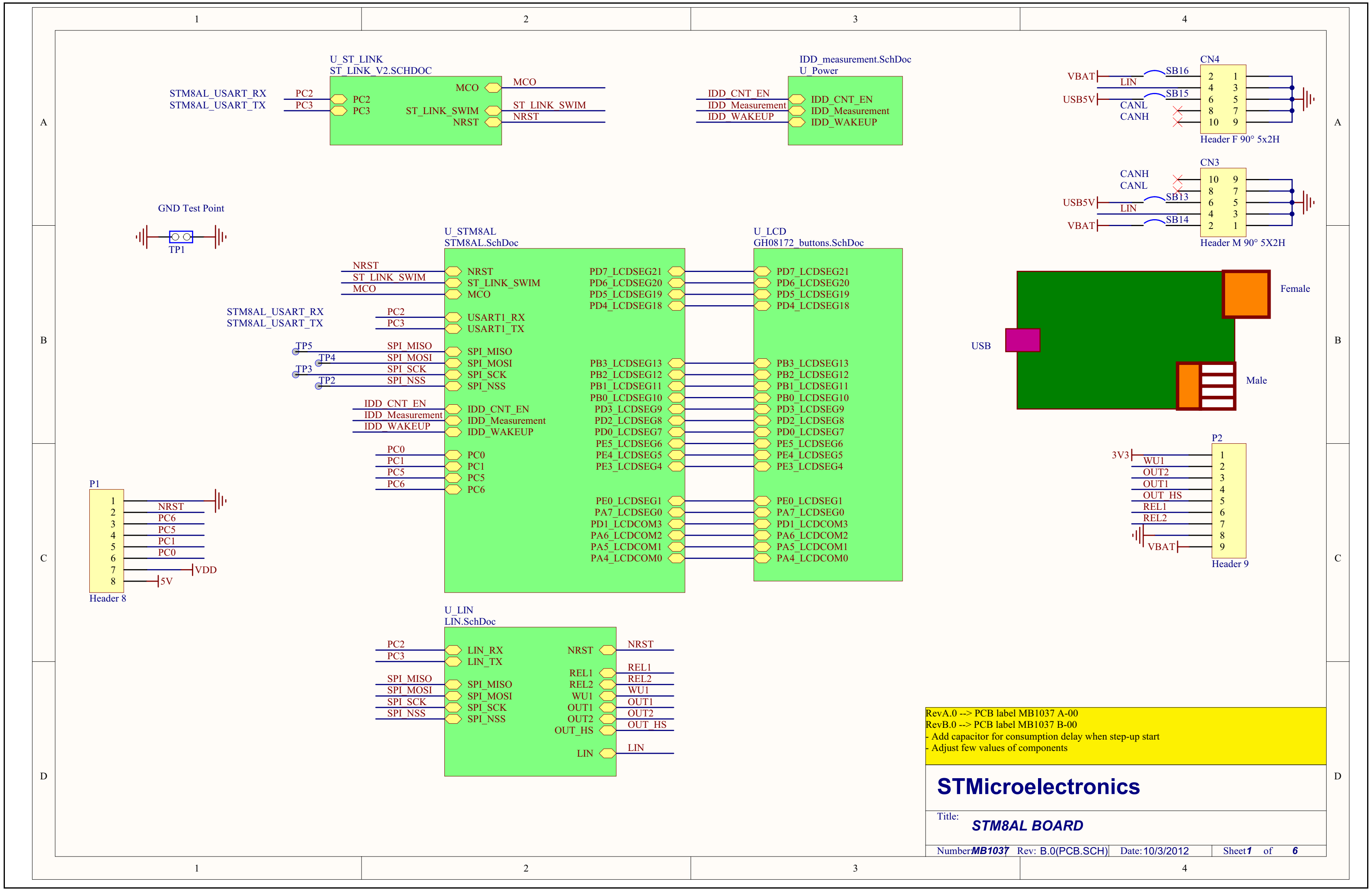
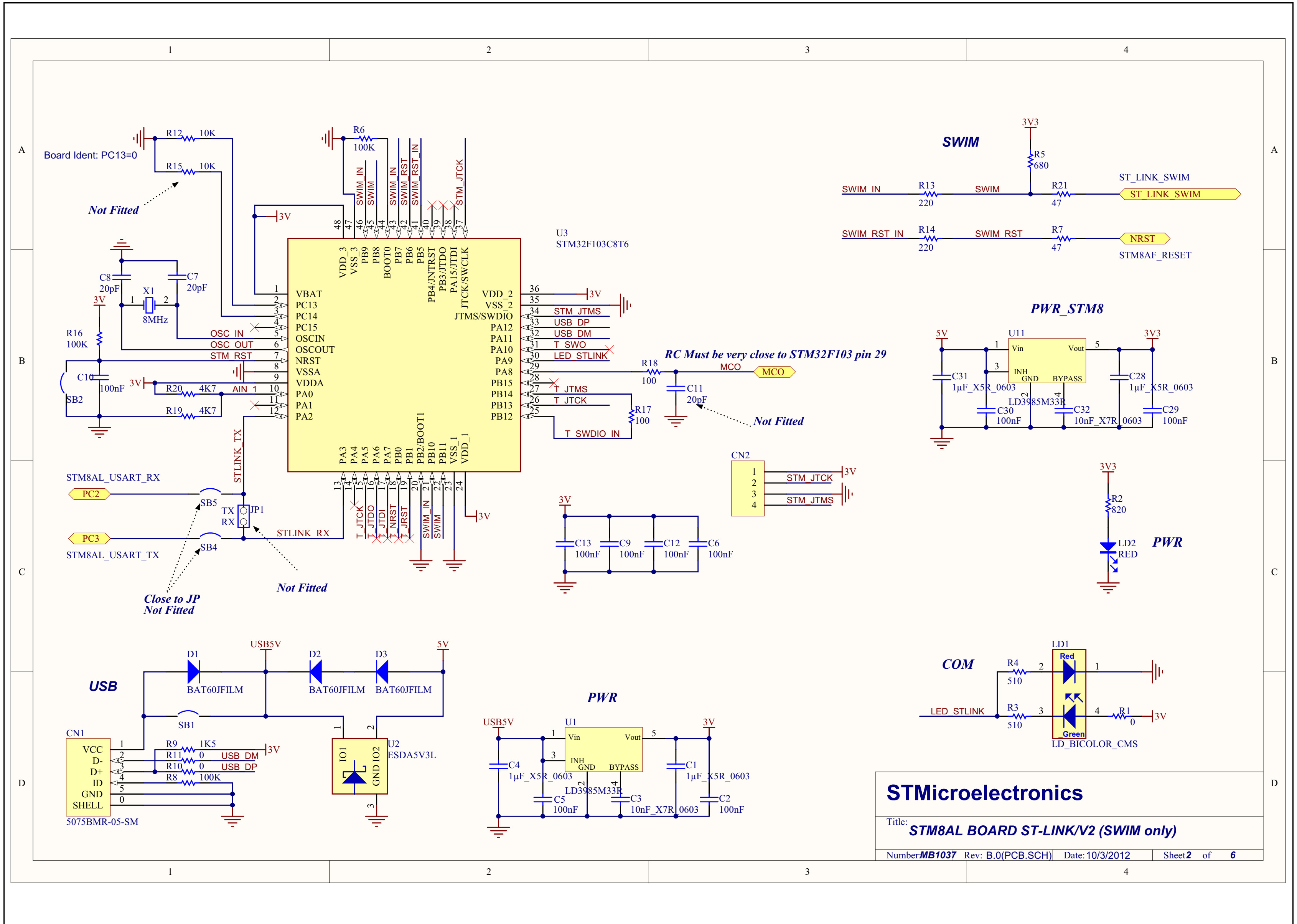
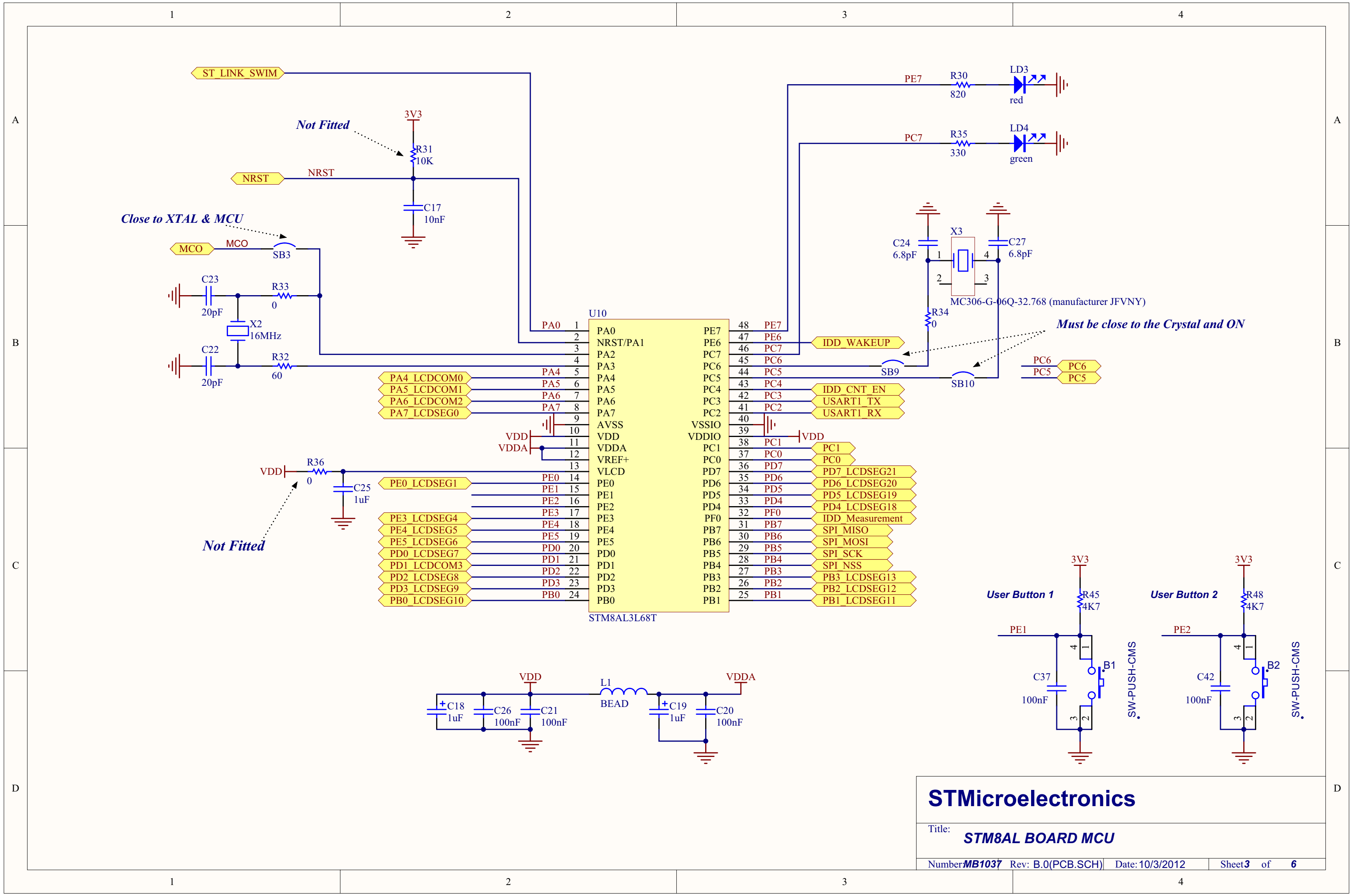


Figure 26. STM8AL board ST-LINK/V2 (SWIM only)

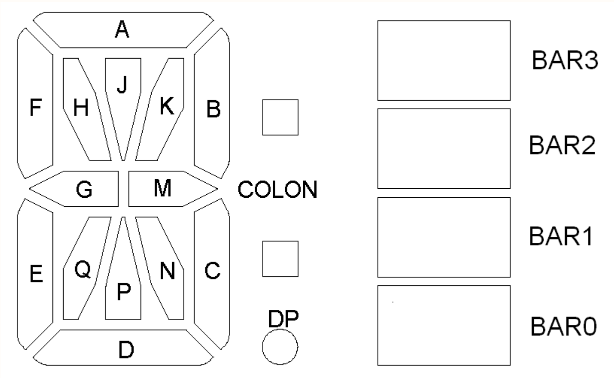


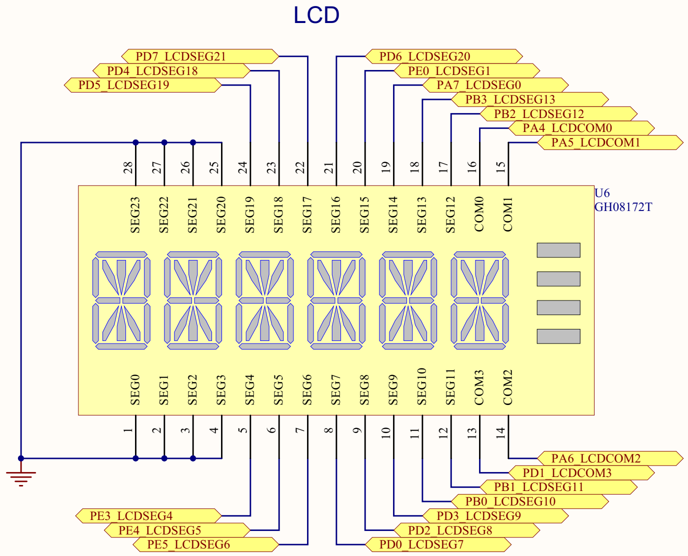
## Figure 27. STM8AL board MCU



## Figure 28. STM8AL board LCD

| STM8AL3L68T | LCD | | | | |
|---|---|---|---|---|---|
| Pin Name | PIN | COM3 | COM2 | COM1 | COM0 |
| | 1 | 1N | 1P | 1D | 1E |
| | 2 | 1DP | 1COLON | 1C | 1M |
| | 3 | 2N | 2P | 2D | 2E |
| | 4 | 2DP | 2COLON | 2C | 2M |
| PE3_LCDSEG4 | 5 | 3N | 3P | 3D | 3E |
| PE4_LCDSEG5 | 6 | 3DP | 3COLON | 3C | 3M |
| PE5_LCDSEG6 | 7 | 4N | 4P | 4D | 4E |
| PD0_LCDSEG7 | 8 | 4DP | 4COLON | 4C | 4M |
| PD2_LCDSEG8 | 9 | 5N | 5P | 5D | 5E |
| PD3_LCDSEG9 | 10 | BAR2 | BAR3 | 5C | 5M |
| PB0_LCDSEG10 | 11 | 6N | 6P | 6D | 6E |
| PB1_LCDSEG11 | 12 | BAR0 | BAR1 | 6C | 6M |
| PD1_LCDCOM3 | 13 | COM3 | | | |
| PA6_LCDCOM2 | 14 | | COM2 | | |
| PA5_LCDCOM1 | 15 | | | COM1 | |
| PA4_LCDCOM0 | 16 | | | | COM0 |
| PB2_LCDSEG12 | 17 | 6J | 6K | 6A | 6B |
| PB3_LCDSEG13 | 18 | 6H | 6Q | 6F | 6G |
| PA7_LCDSEG0 | 19 | 5J | 5K | 5A | 5B |
| PE0_LCDSEG1 | 20 | 5H | 5Q | 5F | 5G |
| PD6_LCDSEG20 | 21 | 4J | 4K | 4A | 4B |
| PD7_LCDSEG21 | 22 | 4H | 4Q | 4F | 4G |
| PD4_LCDSEG18 | 23 | 3J | 3K | 3A | 3B |
| PD5_LCDSEG19 | 24 | 3H | 3Q | 3F | 3G |
| | 25 | 2J | 2K | 2A | 2B |
| | 26 | 2H | 2Q | 2F | 2G |
| | 27 | 1J | 1K | 1A | 1B |
| | 28 | 1H | 1Q | 1F | 1G |




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Title: STM8AL BOARD LCD

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## Figure 29. STM8AL board IDD_measurement

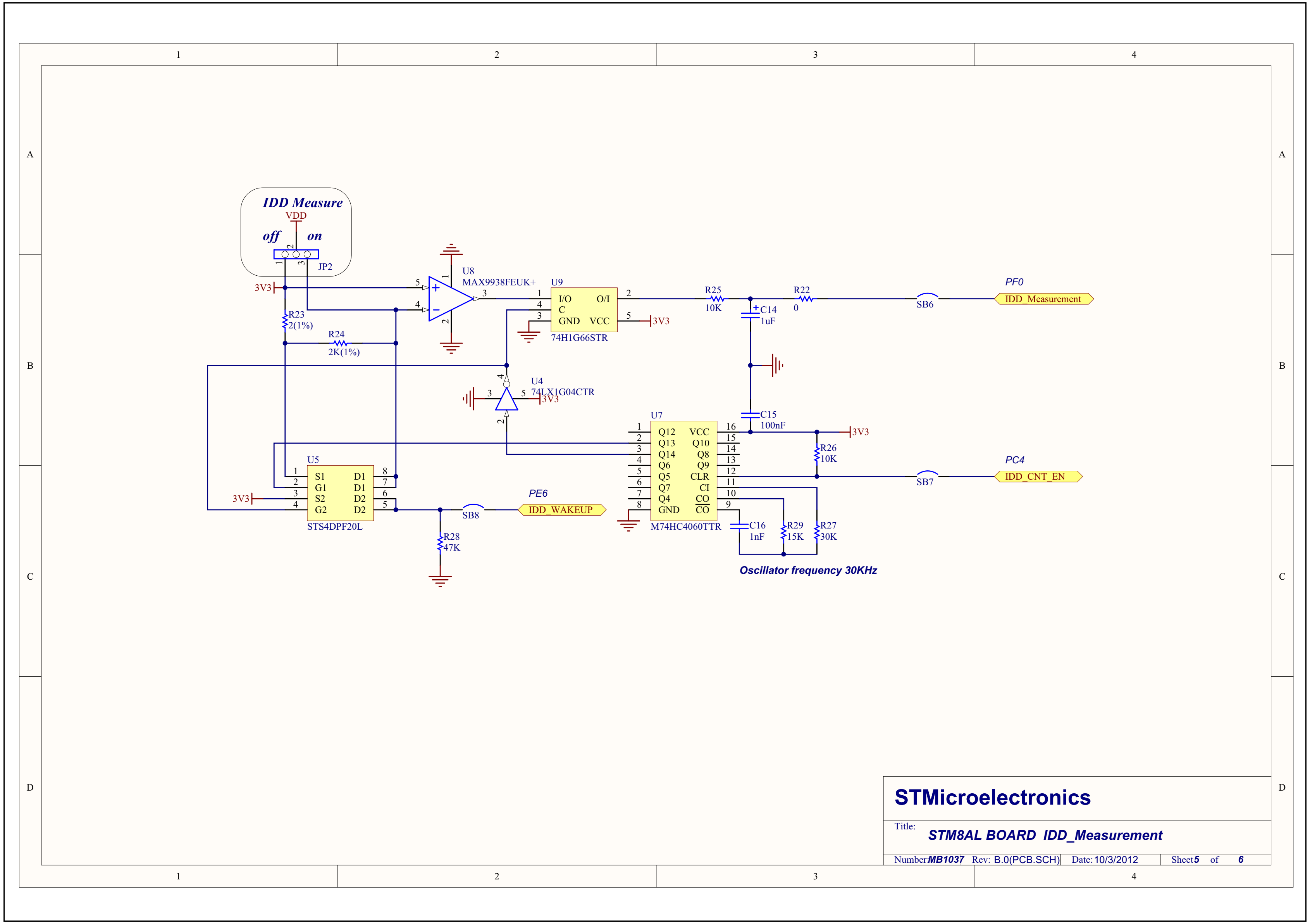
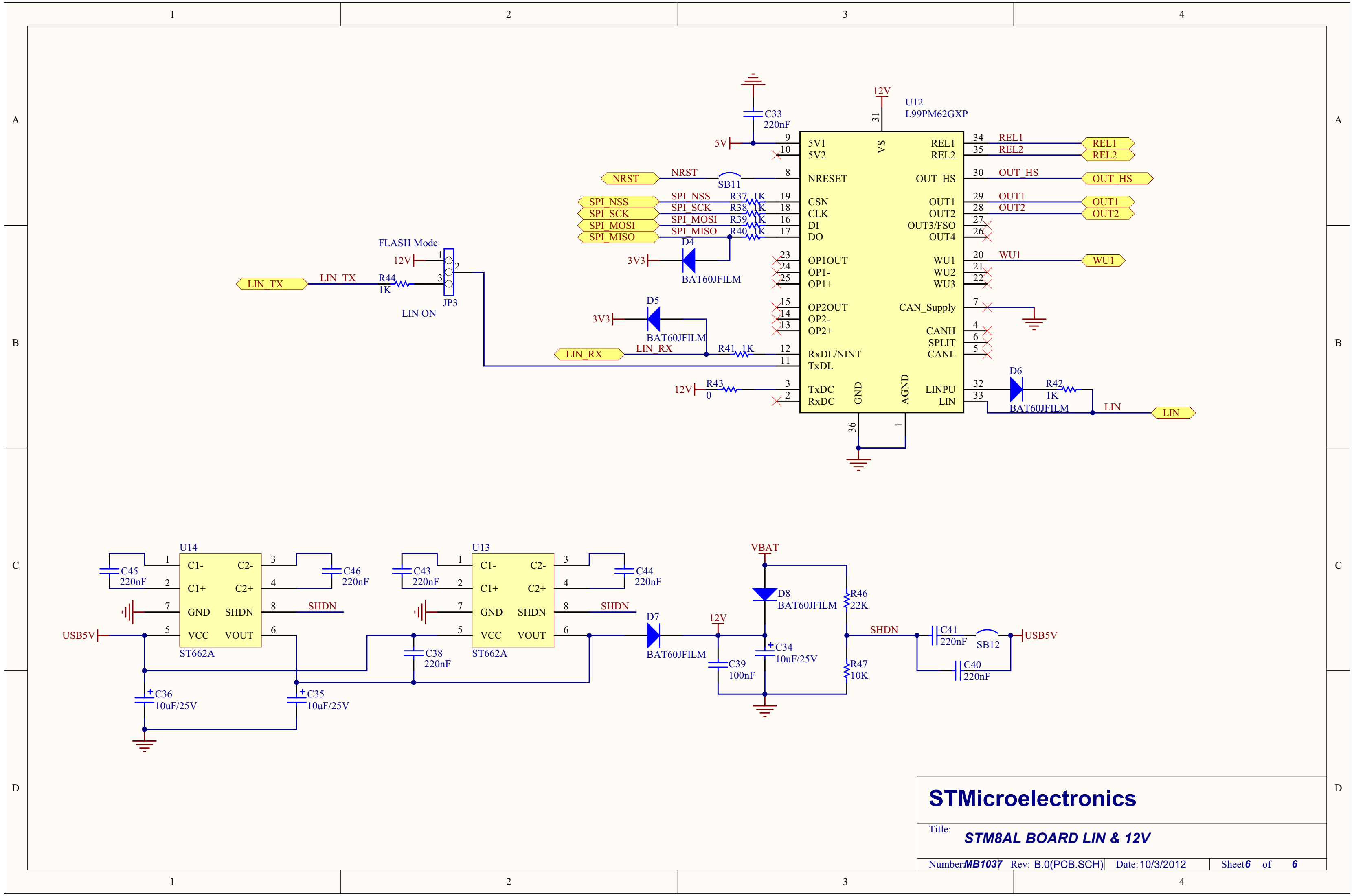


**Figure 30. STM8AL board LIN and 12V**



# 8 Revision history

Table 12. Document revision history

| Date | Revision | Changes |
|---|---|---|
| 15-Nov-2012 | 1 | Initial release. |